# SCIENTIFIC AMERICAN

## No. SUPPLEMENT 619

Scientific American Supplement, Vol. XXIV., No. 619. Scientific American, established 1845. | NEW YORK, NOVEMBER 12, 1887. | Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.


## PRINCE CH'UN.

WHEN the late Emperor T'ungchi, of China, died suddenly, at the age of seventeen, he had not fulfilled the imperial duty of naming a successor, which he should have done from a younger generation than his own. Accordingly, a council of regency, consisting of the Empress Dowager, the widow of the Emperor Hienfung (T'ungchi's predecessor), and Prince Ch'un, his brother, nominated the infant son of Prince Ch'un to the vacant throne. For several years past, therefore, Prince Ch'un has been the most powerful man in the Chinese empire, for, apart from being the Emperor's father, he is prime minister of the empire, lord high admiral of China, and holds several other exalted positions. Last year the Prince came still more prominently before the world, as he determined upon making a short sea journey to various seaports in a Chinese man-of-war, an event looked upon as one of considerable political importance, for the princes of the imperial house usually lead a most secluded existence, and this was the first instance in which a Manchu prince had gone to sea. The Prince, however, appears to have accommodated himself to all circumstances, landed at the various ports and inspected arsenals and armaments, and received Europeans during his voyage with much cordiality. On his return he published his impressions in the form of several poems, some of which have been translated by the *North China Herald*. While displaying a decided predilection for "the China of four thousand years and more, whose civilization and excellence extend to the utmost parts," he showed his appreciation of certain Western innovations, and when at Chefoo Admiral Hamilton visited him, he told him that "England and China must both perfect their drill, and ever cultivate the blessings of peace, so as to preserve a good general situation in Asia."

Prince Ch'un, considering the manner in which China has advanced in many important ways during the past few years, is undoubtedly a remarkable man, and the fact that the present Emperor has been under his tutelage speaks hopefully for the future of China and its relations with the Western world. Our portrait is from a photograph sent by Mr. E. F. Bennett, H. M. Consulate, Tientsin, China.—*London Graphic.*

PRINCE CH'UN, FATHER OF THE EMPEROR OF CHINA, PRIME MINISTER AND LORD HIGH ADMIRAL.

## HUMAN LIFE.

AMONG the most perplexing problems relating to humanity must be included the strange contrast between what men aim at in regard to human life and what would result if their efforts were successful. It is an accepted principle of philanthropy that human life should be carefully nurtured in all available ways: it is a recognized test of good government and of satisfactory progress in civilization that population should increase, and that sickness, pestilence, famine, war, and all death-dealing agencies should diminish. But suppose the efforts of philanthropy, political economy, and science in these directions were successful, suppose that in all the chief nations and among all the principal races the rate of the growth of population were increased, or even maintained unchanged, for but a few centuries—the merest second in the history of the world or even of races—what must inevitably happen ere long? Would human happiness be increased? Would, even in the long run, human life be extended? On the contrary, utter and irretrievable misery would ensue. The human race would deteriorate; nay, its growth and development suddenly ceasing, it would run considerable risk of coming to an untimely end.

I am not an admirer of Mr. Ruskin's philosophy—great though he may be as an art critic and as a rhetorician. I consider, indeed, the attention it has received a most depressing feature of the age, seeing that there is no connection between art and philosophy, or between eloquence and reasoning, and Mr. Ruskin's philosophy is shallow, his reasoning naught. Yet, underlying its absurdly fervid grandiloquence, the following bit of fine writing contains (or rather conceals) a most important truth. "Loss of life!" says the eminent art critic, "by the ship overwhelmed in the river, shattered on the sea; by the mine's blast, the earthquake's burial, you mourn for the multitude slain. You cheer the lifeboat's crew; you hear with praise and joy of the rescue of one still breathing body more at the pit's mouth; and all the while, for one soul that is saved from the momentary passing away (according to your creed to be with its God)" [though as to this, Mr. Ruskin, "you can't quite always generally tell;" the soul thus saved may have—may not, in fact, have done so well]—"the lost souls, locked in their polluted flesh, haunt with worse than ghosts the shadows of your churches and the corners of your streets; and your weary children watch, with no memory of Jerusalem, and no hope of return from *their* captivity, the weltering to the sea of your waters of Babylon."

If the thought underlying this turgid strain is just, if the saving of life cannot be regarded as always an unmixed blessing—and who can doubt this?—how much more obvious should it be that the numerical increase in the number of the living may become the reverse of a blessing, indeed, little better than an unmixed curse, to the whole human race.

Before me lies a statistical record, from which I learn that in England, despite emigration and widespread pauperism (with attendant high mortality), the population during the last twenty years has increased at the rate of 1½ per cent. per annum, with every sign of growing at the same rate, or even at an increasing rate, for many years to come. Admirable country! excellent administration! encouraging outlook for the future! At this rate the population of the old country may be expected to increase tenfold in about 154 years. One rather wonders how the question of wages, already pressing rather seriously upon the English people because of undue numbers, and consequently too close competition (overproduction of workers, in fact), will appear when the encouraging development of the population of England has gone on to this extent. Putting the present population of England at about 30,000,000, the population in 2031 will be 300,000,000, unless the encouraging growth of numbers should in some way be interrupted.

But let us look farther ahead. England is not so young a country but that we can look back over 621 years of her history, to the year 1256, when the first of our English kings to celebrate a jubilee, Henry III., the rather mild son of the not exemplary John, had been fifty years on the throne. During the interval which has elapsed since then a great deal has taken place in England, but England has not grown in population at the rate at which she is growing now. For if she had, that would mean that her population in 1256 amounted only to 3,000 persons, all told; and Cœur de Lion, Henry III.'s uncle, used up ten times that number at least in fighting only. It would seem, then, as though the population of England had not only been growing, but growing at an increasing rate—a result, indeed, which follows still more obviously if the actual population in successive centuries, from the time of William the Conqueror onward until now, be considered. We may then at least look forward for a continual increase at the rate of 1½ per cent. during the next six centuries. What, then, will be the pleasing state of affairs in England in the year 2500 or thereabout? The population increasing tenfold in 154 or 155 years, will by the year 2500 have increased 10,000 fold, or will amount to 300,000,000,000, exceeding some 200 times the probable present population of the whole earth.

There will then be about six square feet of space for each inhabitant of England; and by that time, we may

assume, the three-acres-and-a-cow idea will have had to be given up by the statesmen swaying those 300,000,000,000 "under Britain's royal scepter then." As for the "imperial scepter," with its sway over the colonies and subject populations of Great Britain, it would be difficult to say how it would work, even if the 9,000,000 of square miles forming Great Britain's present empire should by that time have increased to 20,000,000.

But the future of the United States, viewed in the same way, is not less "encouraging," according to one view or less appalling according to the other. The population of America doubles in about twenty years, or five times in a century, five doublings meaning a thirty-twofold increase. In four centuries at this rate the increase of the population of the United States would be about a millionfold (thirty-two times thirty-two times thirty-two times thirty-two times), or the population would amount to sixty millions of millions, or thereabout. This would be a population of about 16,000,000 per square mile, or 10,000,000 per square mile, assuming a fair absorption of surrounding territory, and 4,000,000 per square mile if the whole of North and South America were available for the American population.

About three fourths of a square yard of surface would then be available for each inhabitant of the double continent. If the whole earth were peopled by these 60,000 000,000,000 Americans, there would be nearly three square yards of space for each person.

Of course we know that there is no likelihood of any race or nation increasing in population even at such rates as 1½ per cent. for several centuries in succession. It is not because of any real danger (or hope) that England, for example, which now boasts of this rate of increase during a quarter of a century, or the United States, which boasts of a much greater rate of increase during a much longer time, will continue to grow at this rate, that I have presented the above startling figures. But it is worth while to consider a little how far we are entitled to "rejoice and be glad" over what we regard as progress, when it is clear that the progress cannot possibly continue without ruinous results for the whole human race.

Especially startling, or rather oppressive, become the thoughts suggested by this so-called progress when we remember how much more rapid is the progress of exhaustion of our earth's accumulated stores on which the growing population of the earth in part depends.

It might or might not be possible for the present population of the earth to live, as of old the inhabitants of earth were content to live, upon the annual produce of the earth—on the earth's income, not on her capital.

But assuredly whether this might be done or not, it is not done at present. Year after year the buried stores of life, for that is really what they should be called, are being brought in greater and greater quantities to the surface, and used to supply the human race with much more than the necessities of life.

In two States of the Union alone one kind of accumulated earth life, the petroleum and natural gas store, has been so rapidly used up that within one generation alone stores which were millions of years accumulating will have been almost wholly exhausted.

In Great Britain 150,000,000 tons of coal are yearly brought to the pit's mouth, though it has become clear that the effective supply will be exhausted at the present rate of consumption in the course of ten or twelve generations at the outside.

The forests of the earth, at any rate in all civilized countries, are being steadily destroyed, though it would be quite possible so to arrange matters that the supply used each year should be replaced by new growth during the same time.

Like a spendthrift, the human race of to-day, boasting itself "the heir of all the ages" in intelligence, is consuming at a rate fully one hundredfold beyond what is just the supplies which, as heir of all the geological æons, it has received—in trust partly for future generations.

That men should rejoice when statistical records attest the steady growth of all civilized nations in population, at the very time that the stores of the earth are being wastefully consumed, is as though the father of a growing family should rejoice at each addition to his family circle, at the very time when each year's accounts told him that his means of providing for them were rapidly growing less, and exhaustion was imminently threatened.

I have occasion often, as a student of astronomy, to touch on the gradual dying out of the earth's vitality, and to descant on the limited nature of the sun's supply of life-giving energy. I remind my audiences in lectures, and my readers in books and essays, that as the moon has died so must the earth hereafter die; and that as among the stars (those other suns than ours) we find suns that are manifestly fading in luster, and even evidence of orbs which, though once lustrous, are now dark and dead, so must our sun one day lose his light and heat, and with them his power of sustaining life in the worlds circling around him. But I doubt whether the inhabitants of our world need be very much interested in the future darkness of the sun or in the coming decay and death of the earth. The human race is taking excellent care that its duration shall not extend to either of those dismal times (whichever of them may be the first to come). Millions of years probably before the sun is dark, millions of years before our earth is dead, the civilized human race will have exhausted all that it has to live on, and will have come to an end through sheer inanition.

No discovery of new scientific appliances can avail to save our kind from this end, seeing that every such discovery would inevitably lead only to the more rapid exhaustion of the earth's garnered stores. Progress in civilization, at least along the present lines, can only hasten the coming of the end.

For civilization, as at present understood, culture as at present alone appreciated, imply steady advance beyond the supply of mere necessities, beyond the mere support of life—the steady development of new wants, fresh pleasures, and greater luxury. Nothing could avail to make the increase of life, which so many contemplate with satisfaction, a real gain, or even to justify it, but some such change in the ways of the human race as Cornaro adopted for his own individual habit of life. When he found that he was exhausting the very springs of life, wasting the stored-up constitutional energies of his frame by unduly luxurious living, he wisely changed his way of living to what his friends regarded as a foolishly abstemious regimen.

Condemned by the unanimous voice of the physicians to death within two years, he so developed his vital energies that he lived for sixty-four years instead of two, attaining the ripe age of ninety-nine years before death claimed him. Moreover, whereas in the fullness of his youth and manhood life had been but as a burden to him, life during the last three-fifths of his time—for a quarter of a century beyond the fourscore years, when, the Psalmist says, life is but labor and sorrow—was to him well worth living, nay, full of satisfaction and delight.

The human race is at present certainly advancing with swift strides toward a very desolate condition, if not toward death. It is not getting very much satisfaction out of its wasteful and thoughtless manner of living.

If a few optimists recognize promise of good, more among us pessimistically ask the doleful question, "Is life worth living?" The meliorists who, deploring the evil, still see hope of change to wiser ways are few and low-voiced. Not regimen, which is really needed, but recipe is chiefly suggested by shortsighted men (whom the world mistakes for philosophers) to improve this state of things. Philanthropy, communism, socialism, anarchy, in turn hold out promise of improvement. But in the meantime the stores of life, on which the vitality of the human race as such must depend, are being used up at such a rate that the time of final exhaustion lies within measurable distance. And the statistician boasts, because the records of birth rates and death rates show that the end must be even nearer (supposing no change should take place) than it would be if consumption went on no more quickly than it is already doing.—*Knowledge.*

## NEW GUINEA EXPLORATION.

ON March 15 last a private exploring expedition, commanded by Mr. Theodore Bevan, left Thursday Island for New Guinea in the steamer Victory, which had been placed for six weeks at Mr. Bevan's disposal by Mr. Robert Philp, the owner. Mr. Bevan's object in undertaking this expedition was to ascertain whether it was possible to reach the mountains in the interior of New Guinea by means of the Aird or other large rivers flowing into the Gulf of Papua, and to establish, if possible, friendly relations with the natives in the neighborhood of the gulf, with the view of paving the way for future explorations.

We reprint from the *Sydney Morning Herald* of May 23 the following account of the expedition:

The expedition has proved the existence of spacious waterways leading far into the interior of the island, the two most important—and magnificent rivers they seem to be—having been named the Douglas and the Jubilee. These discoveries may be destined to be of considerable importance to Australia, for a flourishing industrial European community may in the not very remote future settle on the banks of these waterways. Northern Queensland, from its situation, may naturally be expected to reap the greatest advantages from the opening up of New Guinea, but, directly or indirectly, the habitation of its fertile plains and valleys with pioneer settlers must prove beneficial to the metropolis of New South Wales. A comprehensive account of the expedition will be published in due course, illustrated by a chart showing the new discoveries, and by photographic views of new mountain ranges and previously unknown tribes of natives, but a brief description of some of the principal discoveries made will probably be read with interest.

Of the country in the vicinity of the Aird, very little up to the present is known, and at Thursday Island old, experienced hands looked upon it as little short of madness, having regard to the supposed treacherous channels existing and the hostility of the natives, to attempt to enter the rivers which discharge their waters into the gulf. Mr. Bevan, however, paid little regard to the grim forebodings, and the expedition was fortunate in reaching Cape Blackwood in the month of April, at a time when the waters are invariably smooth, and when there is little reason to fear tempestuous weather. The exploring party soon set to work. Several minor streams were discovered, particulars concerning which will be given in due course; but, as already indicated, two new fresh water rivers of magnitude were found, disemboguing their waters through various mouths into the Gulf of Papua. Both these pursue a devious course amid ranges of hills, washing the base at times of lofty mountains. The rivers are longitudinally about 60 miles distant from each other. The first one—the Douglas—is reached by the Aird, up which the Victory steamed, and it became manifest that the Aird was only one of several mouths of the main stream, which was navigated for a distance of 130 miles, but which, however, in reality took the party inland only about 80 miles, by latitude, northward of Cape Blackwood. The explorers left this river through a channel marked upon the Admiralty chart as dry land, and this brought them into Deception Bay. The existence of this passage, in which there is from four to eight fathoms of water, proves Cape Blackwood to be an island. It may here be stated that for the first 30 miles up the Aird the country was found to be of deltaic formation, with alluvia islands scattered here and there; but beyond that the main stream of the Douglas becomes a compact watercourse, flowing between rising ground on either side. The country about the delta is flat, covered with scrub, and the banks are well defined. On the higher waters of the Douglas there is a practically uninhabited forest country, which in parts could be easily cleared. Two important fresh water tributaries to the Douglas were discovered, one of which has been named the Burns and the other the Philp. A new range of mountains observed in this vicinity was named by the leader after his uncle, Mr. Thomas Bevan, an ex-sheriff of London.

The Gulf of Papua has been explored up to Orokolo, and to the westward of that village are what appear to be fine rivers, but these were reported by the natives to be separate mouths of one river, and the natives' report has been confirmed by Mr. Bevan, who, proceeding up a sixth large channel to the west of Bald Head, came upon the main river, which fed the delta and cut inland at right angles into the five other rivers. There was a heavy break on each bar of the first five openings, probably due to southeast weather on the Queensland coast, but a smooth water passage was found into the sixth opening. The time at the disposal of the party was too limited to enable them to survey each opening of the river. So a westerly course was pursued and the Victory steamed up a large channel running in a northerly direction from Bald Head to the point of its confluence with other waters. A week was spent in examining the rivers coming in from the northwest, but, although high land was seen, it could not be reached by any branch in that direction. The easterly passages were next tried, and a channel was found running easterly and northeasterly almost at right angles into two other streams. Taking the branch running inland, they proceeded a few miles further, and found it led into two other streams, one going inland and the other with a current toward the sea as before. Yet again did they meet two other streams, and still steaming up the one leading inland, they, on going 5 miles further, came upon another, and this time the last arm leading seaward. Here they found themselves on a fresh water river nearly half a mile wide, with a steady current flowing toward the sea. A magnificent panorama of rising country was now opened up. Range over range of hills stretched into the distance, capped by some towering blue mountain peaks, and so clear was the atmosphere that even the high mountains, which must have been leagues away, seemed close at hand. They were all clad with trees, and upon the face of them could easily be distinguished the water gullies, brightly illuminated by the glistening rays of the sun. The river was navigated 110 miles from Bald Head, or about 50 miles in latitude from Orokolo, its chief trend being in an easterly and northeasterly direction, although the course was usually serpentine. In honor of Her Majesty's having completed the fiftieth year of her reign, this river, probably the finest in British New Guinea, has been named the Jubilee. The ranges into which the waters carried the little steamer, drawing 9 feet of water, were named the Albert Victor.

Very little trouble was experienced with the natives during the expedition. Only once was the party attacked, and that was when going up the Aird—about 20 miles from its mouth—probably by the same tribe that attacked Capt. Blackwood forty-two years ago. The hostile blacks fired several flights of arrows, some of which fell harmlessly by the vessel's side, but they dispersed at the sound of the steamer's whistle, and after a few shots had been fired wide; neither the attacking nor attacked sustaining the slightest hurt. Through this untoward circumstance Mr. Bevan was unable to obtain the name of the tribe. Another tribe, who evinced their peaceful intentions by carrying green boughs in their canoes, were found inhabiting the country behind Aird's Hill. A third tribe was met with 48 miles inland, as the crow flies, from Cape Blackwood, and these called themselves the Tumu. At the confluence of the Douglas River with Deception Bay, a fourth, the Moko tribe, was found. The Kiwa Pori tribe, the fifth met with, were ascertained to be the inhabitants of the country close to Bald Head, in the Papuan Gulf. The Birumu tribe were seen about 16 miles northwest of Bald Head, and the Evorra, the seventh and last tribe, were found about the same distance northeast from Bald Head. With all, except of course the first, friendly relations were established. Mr. Bevan's previous experience of New Guinea natives and knowledge of some of their habits and dialects were exceedingly serviceable to him; and with the exercise of a little patience he was enabled to inspire them with the fullest confidence. Several natives were induced to go on board the steamer, and were photographed. Only three of the tribes could be spoken of as large, the one possessing the greatest numerical strength being the Kiwa Pori, which numbered from 400 to 500 men. The result of Mr. Bevan's observations is that the country is practically uninhabited except along the coast. No natives were seen on the Jubilee River beyond 25 miles from the coast line.

The best of the land—and fine rich soil it is—appeared to lie between the head of the deltas of both rivers and the foot of the hills, where it looked exceedingly fertile, and covered in places with a palm scrub which could be readily cleared. Sago, tobacco, bananas, bread fruit, and sugar cane were found to be indigenous. As already stated, the country about the deltas is alluvial and flat, and then in turn come sandstone, limestone, and ironstone, as well as the stratified rocks which mark the earlier geological periods. Mr. Bevan hopes, at no distant date, to be able to complete the work of which this preliminary expedition he has now made is but the precursor. In the animal, vegetable, and mineral kingdoms, there is a splendid field for men of science. About eighty ornithological specimens have been obtained by the party, and a few snakes, lizards, and fishes, which will be examined at the Australian museum. A large and varied ethnological collection has also been obtained by Mr. Bevan in exchange for trade from the tribes with whom he established friendly intercourse. Some of the prominent features in the landscape have been named after Mr. Richard Wynne, Mr. F. E. Joseph, Dr. Ramsay, Messrs. Harrie Wood, C. S. Wilkinson, E. Fosbery, and other well-known Sydney citizens.

A word is necessary with regard to the climate, which is described as by no means unhealthy. The temperature varied from 72° F. at daybreak to about 86° in the shade at noon. The party returned to Thursday Island within the time stipulated by the owners of the Victory, in excellent health and with unimpaired physique. The cost of the expedition was from £500 to £600, but from this a considerable sum, represented by the value of the collections, must be deducted. In response to Mr. Bevan's application, the government have placed at his disposal a competent draughtsman to aid him in making up his plottings.

## A SAILING BOAT OF NEW GUINEA.

AMONG the sketches, by Mr. Hume Nisbet, of the scenery and the natives of that part of New Guinea which has been annexed to the dominions of the British empire, we here present one of a "lakatoi," or native trading vessel, belonging to the village of Kerepunu, the kind of vessels employed in voyages along the coast westward to Port Moresby or Motumotu. This part of the coast was first explored by Admiral John Moresby, R.N., in H.M.S. Basilisk, in 1872 and 1873. Kerepunu, which has been described, is situated in about the tenth degree of latitude south of the equator, some two hundred miles east of Cape York, the most northerly point of Australia. The natives carry on much traffic by their annual coast navigation. In

going to sea, two, three, or four of the largest canoes are often placed side by side, and lashed together with rattans. The largest, bound together in this way, are called "lakatoi," the next in size being an "akona," one smaller an "atsi," and the smallest single canoe a "vanaki." The sails are made of the bark of the sago palm, hammered into a sort of felt, or sometimes of matting; they are either square and set between two masts, or of a picturesque elliptic shape. A lakatoi, being a compound vessel, may display half a dozen square sails; it is steered by oarsmen squatting on platforms which project fore and aft, and by other men with oars at the sides. The return of the fleet is anxiously expected in the villages to which it belongs; the inhabitants nightly assemble to chant prayers for a favorable wind. Sago, cocoa-nuts, and other produce of the more fertile districts, as well as foreign wares, are brought in exchange for the pottery manufactured by these people; and there are many dances and feasts to welcome the arrival of the Kerepunu traders when they come home safe and laden with riches.—*Illustrated London News.*

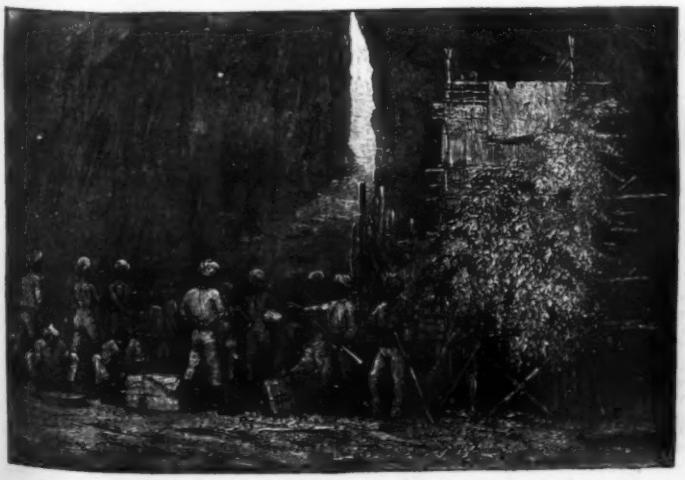
A LAKATOI, OR NATIVE TRADING VESSEL, OF KEREPUNU, NEW GUINEA.

## BRITISH NORTH BORNEO.

ABOUT six years ago, the British government granted a charter giving large power to a company which had acquired, by treaty and by purchase, sovereign rights in North Borneo.

Lovers of natural history will be much interested in the photograph of the celebrated edible bird's nest caves of Gomanton. After a long tramp through dense jungle, the traveler unexpectedly comes on a great hole in the side of a mountain, and then passing round the bushes, suddenly finds himself in a great vaulted chamber, 450 ft. high, which is depicted in our illustration. The cave is inhabited by hundreds of thousands of small swifts and by hundreds of thousands of bats. These live a "Box and Cox" sort of life; the bats swarm out by myriads at dusk, and as soon as they are nearly cleared out, the swifts begin to return to the cave in countless numbers. At daybreak the bats return to their dark crevices, while the swifts come forth to enjoy the sunlight. The edible nests are built by the swifts, and the birds are robbed by the Booloodupies, a jungle tribe who live at certain seasons in the cave, in their houses built on piles. A bird's nest suggests to an Englishman the idea of a mixture of moss, mud, and feathers; but an edible nest is a delicate fabric built like a small bracket against the sides of the cave, and formed of the glutinous saliva of the swift. A good nest is entirely made up of opaque white threads, rather thicker than very coarse vermicelli, and contains neither dirt nor feathers. They are so highly relished by Chinese epicures that the best quality fetch £3 a pound in Sandakan, and not less than £10 a pound in Hong Kong. The royalty paid by the jungle tribes for the collection of nests forms an important item in the revenue of the company.

So much has been written about the relationship between men and apes, that we were particularly anxious to see the great orang-outang in his native home; and marching through the jungle to the nest caves, we were fortunate enough to see and to secure two apes. The world of the jungles of Borneo is built in two stories. The bright and beautiful upper story is on the tree tops, where splendid orchids court the sunshine and numerous brilliant birds flit among the branches. Here the great apes live, feeding on mangoes and durrian, and swinging themselves by their great arms from tree to tree. The forest is so dense and continuous that they need rarely come down to the earth, but travel for miles overhead among the branches. The ground floor is a damp and gloomy world, where a ray of sunshine hardly penetrates, for a tangle of monotonous green jungle, growing straight up, shuts out the light, and swarming with blood-sucking leeches, is sparsely inhabited by men, and pigs, and deer, by the elephant, the wild ox, and the rhinoceros. We give a portrait of the largest male orang. It shows very well the enormous size of his arms, compared with his legs, and his short, paunchy body. The expression and attitude do not, however, do him justice. He was just killed, and had not become stiff, and his jaw had fallen like that of a dead man. So we had to put a prop under one shoulder, and tie an arm to a tree, while Mr. Cooke, who had shot him, supported the back of his neck. The mouth had to be tied up, with a stone inside, to make anything of a photograph of him, and Dr. Walker held the other arm. This makes the animal look misshapen, but, even at his best, he did not seem to be so human as had been expected. The lightly clad figure to the left is a portrait of the Sooloo guide.—*Illustrated London News.*



INTERIOR OF EDIBLE BIRD'S NEST CAVE.

THE HOME OF THE ORANG-OUTANG.

## THE REPUBLIC OF COUNANI.

THE Republic of Counani was a Parisian republic, bounded on the east by the Faubourg Montmartre, on the west by Rue Drouot, on the south by the Variety Theater, and on the north by the Café de Madrid. It was upon this part of the world that it was created, that it lived, and that it died. It had all that distinguishes the governments of other social institutions—a president, ministers, an order of chivalry, and coats of arms. The only thing it lacked was a budget, and that is a grave danger for a republic that wishes to live. A division occurred among the rulers, and nothing remains of their zeal but parchments and decorations of a value more disputed than the territories that gave birth to this jovial adventure.

Counani is one of the six captaincies that occupy the territories situated between French Guiana and the

Brazilian establishments. The possession of these territories has never been determined. Since the treaty of Utrecht regulating the cession to Portugal of the lands situated between the Amazons and Vincent Pinçon Rivers, it has been the object of disputes that have never ended, between France and Brazil. At the epoch at which the treaty was signed (April, 1713), there were no maps of these regions. The Portuguese asserted that the Vincent Pinçon River was no other than the Oyapock, while the French maintained that the river thus designated was much further to the south. Hence conflicts with arms in hand that gave rise to other treaties which were not recognized. Indians and mongrels, the fifteen hundred inhabitants of these territories, left to themselves, conceived the idea some time ago of erecting a government. Why, is not known; and one of the explorers who best knows this country, Mr. Henry Coudreau, has given no hint, in his studies on Amazonia and the Guianas, of the revolution that has just had its *denouement* on the boulevard. Mr. Coudreau merely says that tafia plays a great part in the politics of the disputed regions.

It was at the head of these fifteen hundred inhabitants that Mr. Gros was to have placed himself upon the invitation accorded him by the captain in chief of the Counani River and of the disputed country—a man named Trajane, discovered by the explorer Guigues. The latter had found in Mr. Jules Gros, who was editing articles for geographical reviews, the very man that

MAP OF INDEPENDENT GUIANA.

he wanted. Mr. Gros is bordering on sixty. It is said that he is one of the best of men. Mr. Paul Arene, a great explorer of the Parisian suburbs, says that he met him upon the plateaux of Chatillon, in dead winter, clad simply in a jacket, and making believe that the temperature was mild rather than disturb a squirrel and a dormouse that had selected his overcoat for a dwelling. It is at Vanves, where he dwells, that he signed all the decrees appointing his friends to the highest offices. Mr. Guigues was named minister of state, and Mr. Boisset consul-general, charged with the industrial, commercial, and financial negotiations of the Independent Republic of Guiana, etc.

The most brilliant destiny was smiling upon the young republic, when notes arrived from the French and Brazilian governments announcing that they would tolerate no government upon the disputed territory. Three days after this, Mr. Gros had turned out his friends, and they had turned him out, and nothing remained of the Republic of Counani but a history, which, as no one will dispute, has the merit of being amusing.—*L'Illustration.*

[NATURE.]

## THE LANDSLIP AT ZUG.

To judge by the glimpses which I obtained of English newspapers during my late visit to the Alps, considerable misapprehension has prevailed in this country as to the nature of the disastrous landslip at Zug. For instance, one of the most important journals had a leading article on the subject, describing learnedly the fall of the Rossberg, the destruction of Plurs, and other like Alpine instances, with which the late calamity has no more connection than the slipping of a piece of the Thames embankment into the river would have with the fall of a peak of Snowdon. Hence, as I had the opportunity a short time since of visiting Zug, and in company with my fellow traveler, the Rev. E. Hill, forming an opinion as to the cause of the accident, it may be worth while to give a few details. In drawing up this account I have used the abstract of a report by Prof. Heim, which takes the view which I had already adopted from examination of the locality, and has supplied me with a number of important details.

The newer part of the town of Zug stands on a plain which extends back from the lake to a considerable distance inland. Generally almost level, this at last shelves gently down, falling perhaps a dozen feet in the last hundred yards. The older part of the town occupies slightly rising ground between the water and hills, which in England we should call mountains. Both parts, however, are not founded upon the rock, but upon a detrital deposit. Where are now the streets of Zug was once the lake. The streams from the adjoining hills have encroached upon its waters, and the town stands upon the delta which they have formed; the older upon the coarser, more pebbly material, the newer upon the finer and sandy, where, in prehistoric times, the piles of lake dwellings were driven.

A few years since, the people of Zug thought to improve and beautify their town by building an esplanade in the place of the old irregular shore of the lake. It is faced by a wall of solid granite, which rests on a foundation of concrete, supported by piles. Outside this the water deepens rather rapidly. Still no great depth is reached. Twenty meters from the edge of the quay it is 9 meters; at a distance of 100 meters it does not exceed 20, and even at a distance of 800 meters from the shore has only attained 45. The portion of the quay completed at the beginning of the present summer terminated for a time with a sort of bastion; north of that the piles had been driven for some distance, but no masonry had been laid. Rather more than 100 yards in this direction from the end of the new wall was a steamboat pier, constructed, as usual, of wood.

Twice already in its history has Zug been the scene of disastrous landslips, once in the year 1435 and again in 1594; so that some few months back, when formidable cracks and indications of settlement began to appear in the new quay wall, considerable anxiety was aroused. Prof. Heim, among others, was consulted, and was not able, as a geologist, to offer much consolation, for he could only say that the foundation on which the whole place rested was, as will be seen, naturally defective. Still, as things had on the whole held together in the past, so, after this protest on the part of nature, they might continue in the future. Certain remedial measures were suggested, and a careful watch was kept upon the new structures.

The catastrophe, however, occurred without further warning on July 5. Suddenly, about four o'clock in the afternoon, a large piece of land, occupied by houses and gardens, between the bastion and the steamboat pier, seemed to break up, descend almost vertically, and become ingulfed in the lake. It was a scene of wild and awful confusion, unhappily not unaccompanied by loss of life. A steamboat had just come up to the pier. The waves broke the hawser and drove the vessel more than a hundred yards back into the lake. Here, however, all escaped unhurt, but the occupant of a small boat was upset and drowned, and the landlord of an adjoining restaurant, who had gone from his garden with some guests to see what was happening (for the ground seems to have gone in a series of quickly successive slips, not in one single fall), when the earth cracked beneath his feet, sprang in the wrong direction and was ingulfed in the muddy whirlpool. Three children also perished in one of the fallen houses. Again, about seven o'clock, another and a larger slip took place. The destruction of property was greater, but this time without loss of life, for the people had taken the alarm and evacuated the houses. The dust from this ruin rose like a cloud, and was seen from the Rigi. Since then there has been no further slip; indeed, as we read, no further movement; for the cracks in neighboring walls have been sealed up in many places, so that even a slight settlement could readily be detected.

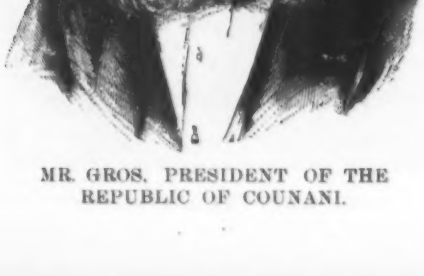
The result of the landslip is as follows: A few months since, there was a street in Zug running roughly parallel with the shore, terminated by a road leading to the steamboat pier, and at the end, on the land side, was a good sized hotel, while between the shed and the lake were gardens with cottages and other buildings. Where once were houses and gardens there is now a kind of bay of the lake. It is as though a pit had been excavated parallel with the shore, which, about 120 meters wide at the water side, extends inland from 60 to 80 meters, widening as it does so on the eastern side to about 150 meters.

This "harbor" is bounded by a low cliff, which rises gradually from a little above the water's edge to a height of about four yards. The surface, however, instead of being occupied by vessels, is a scene of the wildest confusion. Slabs of pavement here, a pile of bricks there, the broken framework of a roof with its displaced tiles, a group of beams, some trees yet living,

in one place the wooded gable of a house, project from the surface of the water, which is covered thick with timber and floating debris. A sadder scene of ruin it would be difficult to imagine. On the land side, part of the pavement of the street yet crests the little cliff, displaced near its edge by a series of vertical faults, with a throw of a few inches. Below, large slabs, with the squared blocks still in contact, lie at various angles on a slope of rubbish which just rises above the water. Houses, cracked and shattered, with their fronts in some cases partially fallen, look down on the scene of ruin, and not a few more in the neighborhood are so injured that they will have to be rebuilt. It is stated that thirty-eight buildings were destroyed in the actual landslip, of which twenty-five were inhabited houses.

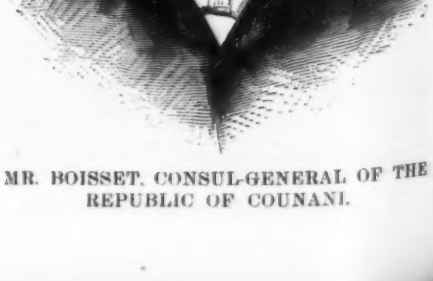
The cause of the landslip is made obvious by examination of the sections which the broken ground affords. That beneath the broken street will serve as an example. Under the pavement for about a yard is a stony deposit, the upper part probably made ground, the lower resembling a coarse gravel. As is natural, it is difficult to decide where undisturbed ground begins. It is enough to call the whole a stony soil, many of the fragments being from the size of the fist to nearly as big as the head.

Probably, however, the lowest foot has been little disturbed. Then comes about fifteen or eighteen inches of a well-stratified gravel—rather iron-stained, the pebbles not exceeding a couple of inches in diameter. Under this is about the same thickness of a rather peaty silt—either an old soil or part of the lake floor, on which aquatic plants have grown; for what seem to be dead rootlets are abundant. Then comes a thick mass of gray silt. It extends downward below the level of the lake—probably to a depth of many meters. This it is which has been the prime cause of the catastrophe. The thick substratum of silt, at times little better than a quicksand, has always formed an unsafe foundation. Too heavy a load, either locally by building too large a house, or generally by building many smaller dwellings, any weakening of the cohesion of the mass, excep-



MR. GROS, PRESIDENT OF THE REPUBLIC OF COUNANI.

ARMS OF THE REPUBLIC.



MR. BOISSET, CONSUL-GENERAL OF THE REPUBLIC OF COUNANI.

tional seasons,* may at any time suffice to pull the trigger of a weapon which, so to say, is always charged. It is doubtful whether this part of the town can ever be regarded as absolutely safe; at the same time, there have been but three slips in four centuries and a half, and no doubt precautions will be taken to reduce the danger to a minimum. It is possible that the building of the esplanade has been the immediate cause. Prof. Heim, however, does not so regard it, though I cannot say that his arguments entirely satisfied me. However, this is certain, that of the completed building only a few feet were damaged. The frontage which slipped was that into which piles alone had been driven.

The most remarkable thing about the slip is that the displacement has been nearly vertical. There has been but little outward lateral movement of the ruined buildings. As Prof. Heim words it in the above named report, "Ground which formerly was from 6 to 2 meters above the water is now from 2 to 6 meters below it." The silty substratum must have flowed outward into the deeper water, or in some way been displaced laterally, to allow of the surface thus sinking. In accordance with this, it is stated that the piles driven for the new wall—which were fixed in the silt alone—were thrust outward for distances of from 100 to 300 meters from the shore, and were pushed up above the level of the water. The catastrophe, then, cannot be numbered with the bergfalls, or even with the ordinary landslips, though perhaps an analogy may be established with some seaside slipping of cliffs; but it is none the less lamentable, for, in addition to five deaths, many families have lost their all—goods, house, and even the site itself being destroyed; and great additional expenditure will be required before the neighborhood can be regarded as safe. T. G. BONNEY.

## SUB-SURFACE WATER SUPPLIES.†

By Professor W. P. TROWBRIDGE.

TWO or three years ago, I prepared a paper for the *Sanitary Engineer*, describing the driven wells, and the method of connecting them with pumps, by which a large supply of pure water had been obtained for the city of Brooklyn from the gravel deposits on Long Island. The simplicity of the means adopted, and the large and constant volume of water obtained, were alluded to as constituting a new and successful experiment on a large scale in connection with the supply of water to towns.

Since the publication of the paper referred to, the Messrs. Andrews & Co., contractors, have established two additional "plants" along the line of the Brooklyn aqueduct, increasing the supply for the city to eighteen millions of gallons daily from this source alone—a quantity equal to one-sixth of the supply to the city of New York at the present time.

This large volume of water is obtained from four hundred and sixty 2 in. tubes (equivalent in area of cross section to a single tube or pipe 44 in. diameter), driven from forty to seventy feet into the gravel deposits. On a trial test, these tubes have furnished twenty-seven millions of gallons in twenty-four hours. Eighteen millions is not, therefore, the maximum supplying capacity of these wells at this time.

It is not contended that there is anything novel in the idea of obtaining water for any purpose from the unconsolidated or loose detritus of the earth's surface; but the means and appliances by which large quantities are drawn continuously and permanently from a few tubes driven into the ground are so effective and simple, and so much has been done to encourage further operations of the same kind, and to throw light upon the characteristics of these underground water-bearing deposits, that it may be said that new resources in connection with the water supply of the largest towns have been opened to the engineer—resources not *always* available, it is true, but in many cases highly practicable and economical.

The engineer who seeks a source from which may be obtained a proper supply of water for a town must take into consideration a great variety of circumstances. Among these, the meteorological and geological conditions which prevail in the district are most important, since these influence the quantity as well as the quality of the water obtained. Of all meteorological agencies, there are none which have more controlling influence on the physical geography of the globe, and the adaptation of any part of its surface to the necessities of the human race, than those which relate to rainfall and the reflux of the condensed waters to the sea. The causes which determine the quantity of rain which falls in any region are various. Ocean currents, aerial currents, mountain ranges, extended valleys and plains—all produce their effects; and although the most varied extremes occur, of regions where vegetation is luxuriant on the one hand and where deserts exist without rainfall on the other, yet such is the constancy of nature in her great cycle of changes that each place receives its appointed share almost unchanged from year to year.

The average rainfall of a region is, therefore, in most civilized countries, one of the best established of all meteorological phenomena.

It is not so, however, in regard to the return of the waters to the sea. The flow of surface streams may, it is true, be determined with approximate accuracy, and their courses are well defined; but the disposal by nature of that large part of the rain which does not appear in the rivers and brooks, as they accumulate in magnitude toward the sea, is involved in much obscurity. A portion of the condensed vapors is known to be absorbed by plants and a portion is re-evaporated, but a still greater part, apparently, disappears beneath the earth's surface. By what precise channels this large volume of water ultimately reaches the ocean; how much of it enters the covered outcrops of porous strata, and, finding its way deep into the earth's crust between underlying and overlying consolidated beds, is ultimately discharged underneath the waters of the ocean; how much enters faults and fissures, and again issues in springs of pure or mineral waters; how much is concerned in excavating underground courses through or among the softer or more soluble rocks, or follows channels already thus excavated, is not and cannot be known. But that no inconsiderable portion of this subterranean flow follows more shallow channels in the loose detritus upon the surface seems probable. In most countries where the rainfall is copious, moderate excavations at the surface reveal the presence of water. In our own country every farm has its well, whether it be situated on a hill or in a valley; and while these wells occasionally become dry in very dry years, it is apparently, in most cases, because they have not been sunk deep enough to reach those water-bearing beds of gravel and sand from which a perpetual and continuous supply might be obtained. The farmer, in sinking a well, looks gratefully for the first indication of water, and as his needs are not excessive, the sinking of the well is stopped when the upper surface of the first water-bearing stratum is reached. The methods and appliances at his command do not permit him to sink deep into watery ground.

The "driven well" goes deeper, and the tube is easily driven through soft ground to any desired depth; while the artesian boring proper pierces the solid strata still lower, if necessary, and draws its waters from sources more distant than those which supply the common or the driven well.

The proportion of the rainfall which passes off by the surface streams is so variable in different places, that actual gaugings of the streams are generally necessary to determine it. Over a large portion of our Northern States, this proportion is from 30 per cent. to 90 per cent. of the rainfall, depending upon the seasons, the surface topography, and the geological characteristics of a district. From 10 per cent. to 70 per cent. of the rainfall for the same localities disappears, being absorbed by plants, re-evaporated from the surface, or sinks beneath it, and of this latter portion there is no doubt that, in many parts of our country, nearly all follows shallow sub-surface channels slowly to the sea levels.

Artesian wells have become so common in every quarter of the globe as to no longer excite especial interest, beyond that which may be attached to the great depths of some and the large volume of flow from others. As a general rule, the hard or consolidated strata of the earth's crust have to be pierced, often at very great depths, to reach water-bearing strata which have been pointed out by precise geological knowledge or which are sought for with much expense and uncertainty where such knowledge is wanting.

While the mechanical processes of boring these wells have reached such a degree of excellence and certainty that individuals or companies may now be found ready to undertake for a specified sum per foot the sinking of an artesian well to any reasonable depth, yet the great cost and the uncertainty of success of any one boring as regards the volume of water which may be permanently obtained causes this method of search for water to be adopted for cities and towns only as a last resort.

If it be proper to classify the systems which have been referred to as the "artesian" and the "driven well" systems, it can be said of the latter that the methods of exploration and well sinking which have been recently developed seem to offer incontestable advantages, and to promise results of the greatest value and importance. Facts have been established, in the explorations already made in different places, which seem to offer strong inducements for further and systematic researches, not only from an economic, but from a scientific point of view. Among the scientific questions presented, those which appear to be of special interest relate to the causes of some of the peculiar phenomena of deposition and arrangement presented in the interstratified beds of gravel, clay, and sand which are found to exist; and if these are connected in any way with ancient river beds, the possibility of tracing out these beds with greater certainty.

A study of these surface deposits by the methods which have been introduced for the driven wells, and which is attended with little difficulty and expense, comparatively, seems to offer, at least, an attractive field for economic and scientific explorations.

Mr. Henry E. Knox, Jr., formerly a student in the School of Mines, has been for many years engaged under the direction of the Messrs. Andrews in prospecting for water in various places, and I am indebted to him for the description of the prospecting device used in that work.

Mr. Knox found between Albany and Troy an extensive bed of gravel beneath a bed of fine clay, from 16 to 25 feet thick near the surface. The gravel bed is from 17 to 35 feet thick, about 700 feet wide, and of indefinite length, it having been traced about half a mile longitudinally.

The gravel from this bed is entirely different from that on Long Island. It is composed of coarser grains or fragments of dark-colored rock, nearly all of uniform size, and less rounded than those from Long Island, showing evidence of that kind of attrition which comes from running water rather than wave action.

Mr. Knox found precisely the same gravel in his explorations near Utica; and under a bed of clay, 118 ft. thick, near Albany, he found a bed of clean gravel, of nearly uniform size and uniform material, but composed of angular, water-worn pebbles as large as pigeon's eggs.

One of the most important questions connected with the system adopted on Long Island, and which has been repeated elsewhere on a similar scale, was the permanence of a full supplying capacity of the wells.

It was urged by some distinguished engineers that the tubes must tap sheets or reservoirs of still water, and that a continued draught upon the system must speedily exhaust the reservoirs.

Experience has not confirmed this view. Mr. Knox informs me that, of the fifteen hundred or two thousand wells selected and driven by himself, not more than two or three have ceased to act, and that in nearly all the supply remains undiminished.

Experiments were made on Long Island to determine the line of depression of the water level in the ground immediately adjacent to the plant of one hundred wells, while the pumps were drawing to their full capacity.

Test wells were sunk just outside of the plant on four sides, and a line of test wells extended out to a distance of 4,000 feet from the pump house. Observations were made during three months. At the distance of 4,300 feet, the water level was reduced about six inches; at a distance of 2,300 feet, about 2 ft. 2 in.; and in the immediate proximity to the wells, within a distance of 300 ft., the depression was 4 ft. 8 in. When the pumps were stopped, all the levels were restored.

The rate of flow to wells sunk in sand or gravel depends, of course, upon the compactness of the material of the water-bearing stratum, the resistance to the flow being proportional to the narrowness of the minute channels through which the water must flow and to the number of windings and turnings which a particle is forced to take throughout its course to the pumps. The velocity of a particle of water running into an ordinary filtering gallery along the margin of a stream is generally less than one foot an hour. The velocity of a particle flowing toward the pumps in the driven well plant on Long Island, taken a little outside the rectangle formed by the hundred wells, is about the same—a velocity too small to be directly perceptible to the eye. This small velocity shows what great relative resistances are encountered.

The form of the water surface will, therefore, depend almost entirely upon the coarseness or compactness of the materials through which the water passes, and is not to be taken as a measure of the degree of exhaustion of the source of supply.

In all the explorations thus far made, it has been found that the gravel beds, available for water, are not continuous over indefinite areas, nor of uniform thickness, but certain beds and particular channels in certain beds appear to constitute the underground waterways, rendering systematic explorations necessary.

The questions which naturally arise concerning these deposits are: What have been the causes of the peculiar arrangements of sand, gravel, and clay? Are the gravel deposits the beds of ancient watercourses, along which the finer sands and clays have been washed away by the streams? Can these old river beds, if they exist, be traced and identified throughout their courses?

In the exploration between Albany and Troy, the appearance of the gravel found seems to indicate a common origin with that at Utica, and it is the opinion of Mr. Knox that the same beds extend along the valley of the Mohawk between these points, but by a route not identical with the present course of that river.

The mode of exploration, which has been described, renders it more simple and less expensive than might be imagined to conduct such researches, although not probably within the resources of private explorers.

An instance has recently come to my knowledge which adds new interest to this subject, inasmuch as in this case water was procured in abundance from a sub-surface deposit in loose material in a region where the small rainfall and the absence of permanent surface streams has heretofore been considered a serious obstacle to any permanent settlement of the region.

Mr. Arthur Macy, a graduate of the School of Mines, having been appointed to take charge of the famous "Silver King" mine in southwestern Arizona, found that for the extensive milling operations that would be necessary in the treatment of the ore, an amount of water would be necessary for which no adequate supply appeared available. A valley of several miles in extent lay above the mines, and, from the appearance of the country, he concluded that this valley, from which flowed a small torrent in the rainy season, must contain sub-surface water. He excavated two open wells, one 15 ft. and the other 25 ft. deep, at the outlet of the valley and about 300 ft. above his mills in vertical elevation and three miles distant from the mills.

A 3 in. pipe was carried from the mills up the valley to the wells, where it was connected to two siphons, one from each well; through these siphons, without the use of pumps, he obtains a continuous supply throughout the year of 200,000 gallons per day.

There is no doubt that Mr. Macy has thus discovered a practicable method of obtaining water in Arizona which may be repeated in many parts of that Territory, and which will be found applicable in many other regions heretofore supposed to be practically deprived of water.

There is now at least abundant experience to encourage the search for and use of subterranean water for the most important uses of life in the shallow and loosely compacted deposits which cover plains and valleys. Another significant example is found in the new water supply for the villages on the east shore of Staten Island. A large part of this island is known to be covered with drift. That portion which is embraced between the principal ridge of serpentine rocks running through the middle of the island from north to south and the dike of basaltic rock which skirts the western shore of the island, both of which have been described by Mr. Britton before the New York Academy of Sciences, is especially to be noted as bearing water—a very large part of the rainfall, doubtless, because the whole area of eight or ten square miles is peculiarly devoid of surface streams.

Along the southwestern shore of the island there are unmistakable indications that the underground flow reaches the surface only a few feet above high water mark. Here the Crystal Water Company have sunk large tubes about 40 ft. into the drift. From these tubes the water destined for the villages along the eastern shore of the island is pumped to a reservoir, 3½ miles distant, situated on the top of the dividing ridge referred to, whence it descends through pipes by gravity about 2½ miles further to the eastern shore, furnishing a head of about 250 ft.

A few years ago, Staten Island and Long Island were supposed to be almost destitute of water, when the prospective wants of their large and increasing population were considered. Now it may be said that in this respect, though isolated from the mainland, they are better off in many respects than New York City. I recently examined, at the request of the trustees of the village of Edgewater, the facilities presented on Staten Island, and had no hesitation in advising that a contract might be safely made with the Crystal Water Company for all the water which would probably be needed for a long term of years. Such a contract has since been made, and the water supply for the towns referred to may be considered assured.

Perhaps my own interest in this subject is derived partially from some of the earlier associations of my life. In the State of Michigan, where I passed my boyhood, there is a tract of country twenty or thirty miles broad, bordering on the river and Lake St. Clair, the Detroit River, and Lake Erie, which is low and heavily wooded, and in wet seasons almost swampy. The settlers of this region had little difficulty in finding water a few feet below the surface, but there were few surface streams, and I have known the farmers to be

* It is stated that the weather changed on the evening of July 5; storms and rain succeeding to a long period of dry weather. At the time, the "ground water" beneath the town was rather above, the lake rather below, its usual level.

† From the *School of Mines Quarterly*, April, 1887.

obliged in very dry seasons to drive their stock several miles daily to water. A belt of country north of this, and stretching from Lake Huron in a southwest direction quite across the State to Lake Michigan, is covered with the most beautiful little lakes of pure and sparkling water—lakes which never become stagnant and never dry up

Farther north again, toward the northern part of the State, are found extensive pine barrens, where again there are but few rivers and streams; but I have seen wells driven there from 6 to 10 ft. only to an abundant supply of water. The little lakes I have referred to are replenished from the exposed outeroppings of gravel beds, and while they are often linked together so as to constitute the sources of considerable streams, the water from most of these lakes seems to sink away slowly again and to flow underground in broad sheets toward the great lakes. Nearly everywhere in this State water in abundance can be found by driven wells, and I am told that in the regions where the early settlers suffered so much from swamps and mud in winter and drought in summer, surface drains and tube wells have created an entirely new condition of things favorable to the farmer.

An objection has been frequently urged against the use of water from these shallow sub-surface deposits that there is danger from pollution or contamination of the water by sewage and surface drainage, the drainage from cemeteries, etc.

While it would obviously be undesirable to establish a driven well plant within the limits of a populous city, it may be said that the necessity for so doing is never likely to occur. Moreover, the purifying influence of the soil by infiltration is known to be very effective; the well-known processes of sewage disposal by irrigation and downward filtration are based upon this property of the ordinary porous soils.

A microscopic analysis of the effluent water from the irrigation fields of Paris showed that the number of microbes in the sewage was reduced from 20,000 per cubic centimeter to 12 per cubic centimeter, and that the effluent water from the irrigation fields contained fewer microbes than the water supplied to Paris for domestic uses. (See Gray's Report to the City Council of Providence.)

The water being drawn from considerable depths, usually the purifying effect of the slow downward filtration from the surface would probably be much more complete than is is produced by any artificial filtration.

It should be a source of public congratulation that while our rivers and streams must become polluted by a growing population, nature furnishes another source of water supply so abundant and widespread, so pure and easily procurable.

Explorations and investigations having in view the more thorough study of this underground water supply deserve and should receive at the hands of the public the most earnest appreciation and encouragement.

## THE APPLICATIONS OF PHOTOGRAPHY IN ASTRONOMY.

By DAVID GILL, LL.D., F.R.S., Her Majesty's Astronomer at the Cape of Good Hope.

So remarkable has been the progress of the miscellaneous application of photography to astronomy within the past year, that some account of it is essential to bring the history of the subject up to date. For example, we have the recent work of Professor Pritchard, of Oxford.

He has applied photography during the past year to the most refined and difficult problem of practical astronomy, viz., the determination of the annual parallax (*i. e.*, the distance) of the fixed stars. He has selected for experiment the interesting double star 61 Cygni. One of the original negatives of the series is now on the screen. This star, as is well known, was selected by Bessel, on account of its large proper motion, as the most suitable star for his first experiment. It was probable, because its large apparent motion among the stars was so great, its real distance from us would be less than that of stars of less apparent motion. Bessel's observations with the Konigsberg heliometer proved this to be the case, and his discussion of these observations first convinced astronomers that the measurement of interstellar spaces was a problem not entirely beyond their reach.

Professor Pritchard has now photographed the star during a whole year, and within a few days he promises that we shall have the results of his measurement of the plates. It will be of great interest to compare his results with previous independent determinations of the parallax of the same star made by other astronomers with different means, but it will be still more interesting for the future of astronomy to compare the amount of accuracy which the photographic method affords as compared with the older existing methods. From preliminary results published by Professor Pritchard, we are led to expect a very high accuracy from the new process.

So far, however, as present experience goes, we shall not be able to apply this new method to the measurement of the parallax of very bright stars, because, when the plates have been exposed long enough to obtain pictures of the faint comparison stars, the disks of the brighter stars become too large and ill defined for exact measurement. It may be that this obstacle will yet be overcome, but at present it has still to be faced.

On the question of the comparative merits of refractors and reflectors as the proper instruments for photographic use, very elaborate comparison has been instituted, and much discussion has been held.

From the simple facts that the best work yet done has been done in stellar photography by refractors, and that they are in many ways more convenient and simple in use than reflecting telescopes, the Paris congress unanimously adopted the refractor as the instrument to be adopted for the international star charts. But here is a very remarkable picture taken with the Oxford reflector, which shows star disk very sharp and very round over a very large field of view, viz., eighty minutes of radius.

In the photography of special objects, such as star clusters and nebulæ, much has been done.

Common's exquisite photograph of the great nebula of Orion you have seen before in this theater, and for exquisite beauty of detail it has never been excelled. But of this we may be sure: that if Mr. Common is spared in health and strength to complete the great reflector of five feet aperture upon which he is now engaged, that photograph, beautiful as it is, will be far surpassed. Here is another photograph of the same object, by Mr. Roberts. So short is the focus of his telescope, so sensitive are the plates he has employed, that the detail of the brighter parts has been completely burnt out, but a great deal of new-found detail is brought to light.

Here is another photograph of the same object by Professor Pickering, taken with a four lens objective, of eight inches aperture and very short focus, and including a field of five degrees square. Exposure, 82 min. This shows what can be done with such a combination.

In 1885 the Brothers Henry, photographing the Pleiades on November 16, discovered a new nebula near the bright star Maia in the group. Here on the screen is a copy of the original negative by which the discovery was made. You observe the nebula like a filmy projection from one of the stars.

After the nebula had been discovered by photography it was found to be visible in the great telescope of thirty inches aperture at Pulkowa. But to discover is one thing, to see after discovery is another.

Strangely enough, this new nebula was really photographed a fortnight before its discovery at Paris, by Professor Pickering, at Cambridge, in America. In exhibiting the photograph to the National Academy of Sciences five days before Henry's discovery, Professor Pickering pointed out the "wing" attached to the star, but there was only one plate shown. The impression was that the mark was due to a defect in the gelatine film.

Here, however, is another picture of the Pleiades taken at Cambridge with the same instrument, and an exposure of eighty-two minutes, which shows nebulosity about more than one star of the group.

And here is a copy of a negative by Mr. Roberts, of Liverpool, with an exposure of three hours. The star disks are of course large and ill defined; but the quantity of nebula, invisible to the eye in the largest telescopes, is quite surprising.

These photographs appear to prove conclusively that the nebula and the stars in this group are one system. The doctrine of chances renders it almost an impossibility to suppose that such a symmetrical arrangement of nebula matter with respect to the stars could exist by chance, if the stars were projected in front of a far distant background of nebulous matter.

Here is a photograph of the stars surrounding the celebrated variable star $\eta$ Argus, taken at the Cape with the telescope of nine inches aperture, generously presented to me for such work by Mr. James Nasmyth. The nebula surrounding this star is very faint compared with the Orion nebula, and it seems to be deficient in actinic rays, and, besides, the telescope is intended for stellar photography by its long focal length, and not for nebulæ, which require a shorter proportional focus—*i. e.*, more intrinsically brilliant image.

Still there is the nebula, and I believe this is the only existing photograph of the object. The exposure was $2\frac{3}{4}$ hours, and yet, although the original negative has been enlarged four diameters, the star disks remain well defined. The corresponding region of the sky is less than the moon's apparent diameter, and of the many thousands of stars visible on the photograph not a single one is visible to the naked eye. The star $\eta$ Argus was in 1843 nearly the brightest star in the heavens—in fact, second only to Sirius. It is now between the seventh and eighth magnitude.

Here is a star cluster in Argus. The star disks are not so sharply defined, but the original negative has been much magnified to bring out the star disks.

Here is a photograph, also taken at the Cape, of the wonderful star cluster $\omega$ Centauri. It is the finest globular cluster in the heavens, and I do not know that I have ever seen the separation of the central stars so distinctly with the eye as they are shown in this photograph. Perhaps, by photographing, we shall learn what motions occur in each cluster. This negative has been enlarged four diameters from the original.

Here is a photograph of the well known cluster in Hercules, taken by Mr. Roberts, of Liverpool, and a still more wonderful one by the Henrys, of Paris. They must be magnified more highly to give any idea of their quality.

When the objects are bright, such as bright double stars, or planets, or the moon, we can enlarge the image produced by the telescope by aid of a secondary magnifier.

Because of the greater size of the original pictures thus produced, the granulation of the photographic film interferes to a less extent with the detail of the picture. Of course, this advantage is purchased at the cost of a longer exposure, because the same amount of light is spread over a larger area of the sensitive plate, and consequently the same area of the film receives less intense light. With very bright objects, such as the sun, moon, and planets, this is of little consequence, and may be an advantage, as permitting more accurate regulation of the exposure.

Here is a picture of the sun photographed by M. Janssen at Meudon, near Paris. The exposure is less than one thousandth of a second of time. And here is an enlarged photograph of the same spot, showing an amount of detail which no artist could convey by hand and eye, nor could he emulate the absolute accuracy of the photograph. Here are some photographs of the planet Jupiter, taken at Paris, the original image being magnified eighteen times. Here is another showing the remarkable red spot—you even have before your eyes evidence of the rotation of Jupiter on its axis by the change in the position of the spot during the same evening. This spot appeared in 1878, and measured about 30,000 miles in length by 7,000 miles in breadth. It became of a deep red color in 1879, and for the three following years was a most striking feature in the planet. It almost faded entirely in 1883, but has again become nearly as bright as it was in 1882.

Miss Clerk tells the story most admirably and suggestively in the last edition of her "History of Astronomy," to which work I would refer those of my hearers in whom these beautiful photographs may excite a sufficient interest.

To enter fully into the matter would demand a lecture to itself—and the minute hand of that inexorable clock warns me that I must move on.

Here are some photographs of Saturn which illustrate the remarkable progress of celestial photography.

Here are some photographs of double stars. One of these, a photograph of $\gamma$ Virginis, taken at Greenwich, is probably the finest photograph of a double star in existence. The star disks measure less than 1″ in diameter.

Last of all I come to the most recent revelations of the power of photography as an aid to astronomy. Dr. Henry Draper, in 1872, was the first to photograph the lines in the spectrum of a star, but his admirable investigations were interrupted by death in 1882. In 1886, his widow placed in the hands of Professor Pickering, of Harvard College Observatory, in America, not only an ample sum of money for the purchase of costly apparatus, but also made a liberal provision for carrying on the work of photographic spectroscopy as a memorial to her husband. So noble a gift, and the execution of so pious a purpose, could not have been placed in abler or more active hands.

Within the past few weeks we have received the first fruits of Henry Draper Memorial Fund. When I began preparation of this lecture, I cabled to Professor Pickering for some glass copies of his original negatives. He kindly complied, and they arrived this morning. Time only permits me to show them rapidly, but those who remember Dr. Huggins' lectures on stellar spectra in this theater will recognize the enormous importance of such pictures as these. The ingenuity of the adopted methods, the extraordinary success attained, the promise of rich harvest, exceeding our highest expectations, which the results afford, are themes upon which one could dilate for hours.

Here we have the spectra of the distant stars whose actual disks we can never hope to see, registering in these rythmical lines the story of their constitution and temperature, with an accuracy and precision which not many years ago we should have been glad to obtain in the records of the spectrum of our own sun. And this is not all. Not only have we such results for a few stars, but we are promised that "the complete work will include a catalogue of the spectra of all the stars of the sixth magnitude and brighter, a more extensive catalogue of spectra of stars brighter than the eighth magnitude, and a detailed study of the spectra of the bright stars." These are Professor Pickering's own words.

What Professor Pickering promises, we know from long experience that he will perform. We may also well say with him that "a field of work and promise is open, and there seems to be an opportunity to erect to the name of Dr. Henry Draper a memorial such as heretofore no astronomer has received."

There is in England wealth enough and to spare. Many a rich man dies puzzled how to dispose of his money; and there is many a living man who would gladly give for such an object if he knew how to do so. There is field enough in astronomy, and there are men enough in England to do the work. Let us hope they will receive aid such as Professor Pickering has received; and having done so, they will give an equally good account of their stewardship.

The miscellaneous applications of photography to astronomy offer a field so full of promise, so certain of immediate reward to those who are possessed of the necessary originality and the means to carry out their ideas, that there is more hope of private enterprise in that direction than in the more routine work of star charting.

But tempting as these fields are, brilliant and interesting as are the discoveries to be found in them, there is in the work instituted by the Paris congress an element that cannot be overlooked, and which compels attention; it is this: the question of the lapse of time. Every year which passes after that work has been carried out, increases its value and importance. Every year that we neglect in doing it will be a reproach to the astronomers of the day. Into all the great problems which that work is destined to solve, the element of time enters; and time lost now in such work can never be recalled.

Of the congress itself I would say a few last words. Its proceedings were characterized by an earnest spirit of work and entire absence of international jealousy. Our reception by the French was cordial and hospitable in the highest degree, the decisions of the congress were almost unanimous, and were marked by a moderation and judgment which must render them acceptable to the responsible authorities of the various governments.

Lastly, I would add that the good will which pervaded the meetings, the general success of the congress as a whole, were in no small degree due to the genial influence of the single-hearted, earnest-minded man who convened it—Admiral Mouchez.

[INDIAN AGRICULTURIST.]

## THE CLOVE TREE.

THE clove tree (*Caryophyllus aromaticus*), says Rumphius, "appears to me the most beautiful, the most elegant, and the most precious of all known trees." In form it commonly resembles the laurel, and sometimes the beech. Generally of the height of an ordinary cherry tree, its trunk is straight, and rises to four or five feet before it throws out branches. The bark is smooth, thin, and adheres closely to the wood, which is hard and strong, but of an ugly gray color, and, therefore, not suited for cabinet work. In the commencement of the wet season, which is the month of May in the native country of the clove, the tree throws out a profusion of new leaves. Soon after, the germs of the fruit are discovered at the extremities of the young shoots, and in the four following months the cloves are completely formed. The fruit, at first of a green color, assumes in time a pale yellow, and then becomes of a blood red color, if of the most ordinary variety. It is at this period that the clove is fit to be used as a spice, and of course this is the period of the clove harvest. It is not, however, the period of the full maturity of the fruit, which requires three weeks longer to perfect itself and serve for the purposes of propagation. In this short period the fruit swells to an extraordinary size, loses much of its spicy quality, and contains a hard nucleus like the seed of the bay. This state of the fruit is what Europeans call the mother clove, and the natives *poleng*.

There appear to be five varieties of the clove, viz., the ordinary cultivated clove, the clove called the

female clove by the natives, which has a pale stem; the keri, or loory clove, the royal clove, which is very scarce, and the wild clove. The first three are equally valuable as spices, the female being considered fittest for the distillation of essential oil. The wild clove has hardly any aromatic flavor, and is of course of no value.

Of all useful plants, the clove has perhaps the most limited geographical distribution. It was originally confined to the five Moluccas islands, and chiefly to Machain. From these places it was conveyed to Amboyna a very short time only before the arrival of the Portuguese. The portion of Amboyna called Leytimeer, and the Uliasser islands, produced no cloves until the arrival of the Dutch, by whom the cultivation was restricted to Amboyna, every effort being made to extirpate the plant elsewhere. To what distance from the parent country the culture might be successfully extended, there has been no opportunity ascertaining.

Rumphius informs us that the plant is not partial to large islands, and does not answer well in Gilolo, Ceram, Beuroe, or Celebes. It is probable that Beuroe and the Xula isles are the utmost western limit of the successful culture of the clove. The same writer adds that the Javanese and Maccassars, when they were the carriers in the spice trade to the western emporia of the Archipelago, conveyed to their own country with great care young clove plants and mother cloves, from which trees were reared that produced no fruit.

Through the speculative enterprise of Europeans the clove has in latter times been cultivated so as to bear fruit in some of the western parts of the Archipelago, in the Mauritius, and in the West Indies. They have been cultivated for nearly fifty years in the Mauritius, where they bear fruit of inferior quality and high price. The fact seems to be that, like the grape, but in a much higher degree, the clove may be raised at a heavy expense, and of inferior quality, in soils and climate little suited to it.

How wonderfully restricted the soil and climate of the clove is may be gathered from this well-known fact, that in the parent islands the tree yields fruit in the seventh and eighth year of its growth, and grows almost spontaneously without care or culture, whereas at Amboyna, where it is an exotic, it does not bear until the tenth and twelfth year, and demands very considerable attention.

The clove neither thrives well near the sea, where it suffers from the spray, nor in the higher mountains, where it suffers from the cold. The soil which suits it is a dark loam, having underneath a layer of dusky yellow earth intermixed with gravel. A sandy soil, a hard clay, and the wet ground in which sedges grow are to be avoided. The tree may be propagated either directly from the mother cloves or by transplanting the younger plants found in the clove gardens from the natural propagation of the seed. The plants raised by the first method grow luxuriantly, but are alleged to yield more leaves than fruit, and, growing remarkably straight, to be difficult to climb for the purpose of reaping the harvest. The trees propagated by the latter method are preferred, but the culture is laborious, and the success of the operation uncertain until the plants have attained the height of five or six feet. The young plants at first require the shade of other trees, and must therefore be planted among them. As they grow up, the other plants must be removed, leaving here and there a few fruit trees, such as the kanari and the cocoanut, etc.; the neighborhood of which, it has been discovered, is favorable to the clove. The clove trees must themselves be kept pruned, and care be taken that they are not choked with weeds or by too many of the fruit trees just mentioned, in failure of which attention the plants will languish or degenerate into wild cloves.

Such is the culture requisite in Amboyna, a soil and climate foreign to the plant, where comparatively much care and attention are required. In its native country, on the contrary, the clove grows luxuriantly and almost spontaneously, being propagated and coming to perfection with hardly any culture. In its native country, the clove tree, as already mentioned, begins to yield fruit in the seventh or eighth year, but at Amboyna not until the tenth or twelfth.

Examples are given of clove trees living to the age of one hundred and thirty years, but the ordinary duration of its life in Amboyna does not average above seventy-five. Much depends upon the nature of the soil and ground in which the tree has taken root.

The clove, though generally a hardy plant, suffers from excessive drought, and is apt to be destroyed by the depredations of a worm which insinuates itself into the wood and kills the tree. In particular seasons thousands perish from this cause. The reaping of the clove harvest is perfectly simple. When the fruit begins to grow red, the reaping is begun. The ground underneath the tree is clean swept. The nearest clusters are taken off with the hand, and the more distant with the assistance of crooked sticks. Great care is necessary that the trees, in this operation, should not be rudely handled, as an injury offered to them in this way would prevent them from bearing for years. The curing of the cloves consists in placing them for some days on hurdles, where they are smoked by a slow wood fire, which gives them a brown color, and afterward drying them in the sun, when they turn black, as we see them in the article of commerce. In some places they are scalded in hot water before being smoked, but this practice is not common. Such cloves as casually fall on the ground and are picked up in small quantities, the cultivators do not think it worth while to subject to the process of smoking, and they are merely dried in the sun; they are discoverable by their shriveled appearance, and are of inferior value. The period of harvest is from October to December.

Of the fecundity of the clove it is not very easy to speak distinctly. The produce from one year to another is very unequal. At intervals of from three to six years they usually yield one extraordinary crop, but then a year now and then intervenes when they do not bear at all. At other times, again, they will give a double harvest. Some extraordinary instances of fecundity in particular trees are quoted. Rumphius and Valentyn speak of a remarkable tree, a hundred and thirty years old, which one year gave the enormous crop of eleven hundred pounds and another year half this quantity. About the proportion of two thirds of a clove cultivation is considered to be bearing trees, the remaining third being allowed for barren and young trees. According to the present mode of culture, perhaps, it would not be safe to average the production of all trees at above five pounds.

According to the data, the produce of an acre will be 375 pounds avoirdupois, and deducting one-eighth for young trees under ten years, 328 pounds. By a free culture, as in the case of pepper, a much larger produce than is here stated would no doubt be obtained.

## THE CULTIVATION OF THE CASTOR OIL PLANT.*

ACCORDING to a common saying, the castor oil plant can be grown wherever Indian corn will grow. Yet this saying does not quite correspond with the facts, because, while it may accompany corn northward as an ornamental plant, if the locality is favorable, its profitable cultivation is only possible in certain zones. In the United States, for instance, the northern limit is about the middle of Iowa, and, as far as altitude is concerned, the castor oil shrub remains from 2,000 to 3,000 feet below the level at which corn may still be raised. The castor oil plant is not a food plant like corn; its only value lies in its yield of oil, and the warmer its place of growth, the more oil will it yield. Hence it would be folly to expect large profits (if any at all) from the cultivation of the castor oil plant in unsuitable localities.

The question of the applicability of any given locality for this cultivation, however, depends for answer upon still other conditions besides atmospheric temperature. It is necessary to take into account the available moisture. In many parts of the subtropical zone the coldest period arrives at the close of the rainy season, which corresponds to the winter. This cold period must be allowed to elapse completely before sowing can take place. For neither corn nor the castor oil shrub can stand the slightest frost, and their seeds rot in the ground unless the latter is thoroughly warm. This condition is not fulfilled until after the rainy season is over. Of course, where the natural rainfall is defective, artificial irrigation may be used, but this is never as effective as the former.

Before starting any plantation of the castor oil plant, the amount of available moisture, either natural or artificial, must be thoroughly studied.

The castor oil plant requires a very rich soil, if it is to yield an ample crop, as may be seen from the following composition of the ash of the seeds:

| | |
|---|---|
| Lime | 88·38 |
| Magnesia | 7·33 |
| Oxide of iron | 0·89 |
| Phosphoric acid | 38·65 |
| Sulphuric acid | 2·21 |
| Chlorine | 0·89 |
| Potassa | 29·52 |
| Soda | 8·75 |
| | 100·00 |

Attention is called to the large amount of potassa, and particularly to the extraordinarily high percentage of phosphoric acid. The plant also requires a copious supply of nitrogen. Unless the cultivation is started on virgin soil, manuring can scarcely be avoided, though it would be useless to expect everything from artificial enrichment of the soil. The latter must be naturally adapted to it. It must, besides, be neither too loose nor too dense; neither stiff clay nor loose sand answers the purpose. A clayey sand or sandy clay bottom or alluvial ground is most conducive, provided it is of sufficient depth and porosity.

While it would be the most rational method to ascertain the capabilities and requirements of a soil by a chemical analysis of it, made from time to time—and this should be done if at all possible—yet in many cases this will be impracticable. It is, therefore, of advantage to know a manuring compound which is likely to furnish all the required constituents, without doing harm by the presence of one or another in excess. Such a compound is produced by a mixture of—

| | |
|---|---|
| Cotton seed | 750 parts. |
| Stable manure | 750 " |
| Superphosphates | 500 " |

If cotton seed cannot be obtained, the following may be used:

| | |
|---|---|
| Cotton seed meal | 500 parts. |
| Stable manure | 1,000 " |
| Superphosphate | 500 " |

These substances are to be made into a heap, under cover, and to be thoroughly moistened, in order to prevent overheating and to promote fermentation. After six weeks the mixture may be applied to the fields, from 1,000 to 3,000 pounds per acre, according as may be required. The soil must be turned deep, as the roots of the shrub penetrate to a considerable depth.

When the soil has been properly prepared, sowing may commence. This should be done in the beginning of the rainy season, except where frosts are to be expected near its end, in which case the beginning of the hot season must be awaited. The next question to be decided is which variety is most suitable for the locality. If the common species be employed, which usually grows to the height of about eight feet in the subtropics, the plants must be placed at intervals of four feet in all directions. Under the tropics the shrub grows two or three feet higher; the distance here must be five feet. If a still higher variety is chosen (such as *Ricinus sanguineus*), the distance should be extended to eight feet.

In planting out on a large field, supposing the distance between the plants is determined at five feet, it is advisable to leave a space of seven feet after every five rows of five feet apart, but only in one direction. This wider passage facilitates the harvesting.

The seed beans are soaked for twelve hours in lukewarm water, then laid in pairs in the marked places, and covered with earth one inch high. As soon as the plants are three to five inches high, the weaker of the two plantlets is pulled out at every place. Sometimes four beans are planted at a time, and the two weakest ones pulled out, but this is not to be recommended. If economy of space is necessary, it is better to put the plants closer together, rather than to duplicate them in one place.

The field requires only a repeated loosening of the soil with the cultivator, not with the plow, as this penetrates too deep and injures the roots. Hence, even the cultivator must be adjusted at a rather slight depth. How often this operation should be performed depends on the weather. Four repetitions are usually sufficient. Of course, the soil in the immediate vicinity of the plant must be loosened with the hoe or rake.

So far as known to the author, the castor oil plant is only attacked by one insect, the same as infests the tobacco plant; all other insects shun it. In fact, the presence of the shrub appears to be a good agent to repel insects of all kinds. For this reason, probably, it is customary in some tropical districts to surround the field with several rows of castor oil plants, a practice that appears to deserve imitation. When the pods ripen they turn brown, hard, and brittle, and begin to burst. All pods do not ripen on the plant at the same time, but the ripening process proceeds from below upward. Hence the harvesting must be done in several installments. For this purpose it is quite customary to use a sort of sled, drawn by a docile horse or other animal, which is guided through the wider passages of the field, while the ripe capsules are collected at either side of it and thrown into the box of the sled. A smooth ground is previously prepared at a suitable place in the neighborhood, and surrounded by a board fence four to five feet high. Upon this place, which must be exposed the greater part of the day to the hot rays of the sun, the capsules are piled to a depth of three to four inches and turned over with a shovel once each day. With favorable weather, the capsules burst completely in four or five days. In order to separate still adhering seeds, a very light roller, drawn by an unshod horse, is rolled several times over the ground, the capsules being turned over before each new circuit.

The capsules and beans are then put in one heap, and the latter separated from the former by a winnower or by means of throwing with a shovel.

The ground having been cleared, it is ready for the next crop, and this is continued until the harvest is over. The shrubs are then cut down and put in the compost heap.

The clean beans are finally put in bags, and sold to the miller.

In the East Indies the oil is extracted by crushing the beans between two rollers. The mass is packed into hempen sacks, and expressed by a screw press. The oil is mixed with water, and the latter raised to boiling. This causes the impurities to rise to the top. The oil is next strained, bleached by exposure to the sun, and transferred into casks. In Oudh, the crushed beans are boiled with water, and the oil which rises to the surface gradually dipped off.

In the United States, the usual process followed is to expose the beans in an oven for an hour to a dry heat, which has been found to facilitate the extraction of the oil. They are next transferred (in bags) to a strong screw press, and the oil, as it runs out, immediately mixed with an equal measure of water. The mixture is boiled for an hour, which causes the coagulation and separation of the albuminoids contained in the oil. After cooling, the oil is drawn off and transferred to large zinc tanks, in which it remains eight hours. Finally, it is exposed to the sun to bleach. One hundred pounds of beans yield about eighteen quarts of oil. The finest oil is obtained by a process which, according to the author, is only partially known. The beans are first passed through rollers in which their peel or skin is taken off, which contains an oil of disagreeable taste. They are then crushed, and either cold-pressed or extracted with alcohol. The oil is finally purified by contact with acids, and the final product is a fine, clear, nearly colorless oil, almost devoid of odor and taste.

* Extract from "Die Tropische Agricultur. Ein Handbuch fur Pflanser und Kaufleute." Von Heinrich Semler in San Francisco. Vol. ii., 8vo. Wismar, 1887. From the *American Druggist*, June.

## THE HERKOMER SCHOOL.

THE first meeting of the Herkomer school, under the new constitution, has been lately held. The president (Professor Herkomer, M.A., A.R.A.) having taken the chair, the treasurer (Mr. T. Eccleston Gibb) said: This school has now been carried on for four years, and it has achieved a success which does not usually follow new institutions. During that time I have taken the chief responsibility connected with finance, and Professor Herkomer has entirely controlled the teaching. We commenced without any written agreement, simply trusting each other as friends. We promised each to do his part, and we have never had a dispute or misunderstanding. It is not for our sakes, but for the sake of the future of the school, that the constitution of our school is to be changed, and it is for you—the fellows, associates, and students of the Herkomer school—to make, or assist us in making, the influence and benefits of the institution still further felt.

We have adopted a new constitution, and are now to be governed by formal by-laws, rules, and regulations made by a council and by an academic board, instead of being governed, as heretofore, by the mutual wishes of two individuals. We have taken new responsibilities. We are an art colony modeled on a perfectly unique plan, combining many of the advantages of the teaching systems of the ancient masters with what is best in the systems of modern art schools, and we are presided over by one who as a teacher and as a man stands unsurpassed. The Herkomer school comes at an important time, and assumes an important place. Its doors are open only to those who are sincere and thoroughly in earnest in their desire for study. It is not a place for beginners, yet in this respect we have modified our original plan by establishing the preliminary class. . . .

Professor Herkomer then delivered an address, from which some extracts are here made:

My dear students: I will now give you my sketch of the school. This school, which bears my name, is unique in the history of art schools—unique in its origin, in its locality, in its method of tuition, and (for the short time of its existence) unique in its results. The whole secret of this is bound up in the fact—the singular fact—of my having a neighbor in Mr. Gibb, who was generous enough to give a large sum of money for the building of this school, which was to have no other authority or influence than my own. This absolute power alone has enabled me, through difficulties and

complications, to stop all dangerous influences, and to give to the school the life and vitality that will now, in its new form, continue to stamp it through its whole (I hope long) future. . . .

We aim at retaining the English feeling for nature, with the addition of some better technique than is encouraged in most English art schools. We further aim at the individual development of each artistic nature, and I have already had my strong belief in the possibility of this method strengthened by the results. Not one of our successful students has a touch of my own manner in painting. This is one of the school's triumphs. No samples to guide or misguide you, and no prize work, has brought this about. Working for prizes would soon lead to a school manner, and then to a mannerism that would become a barrier to all individuality of style.

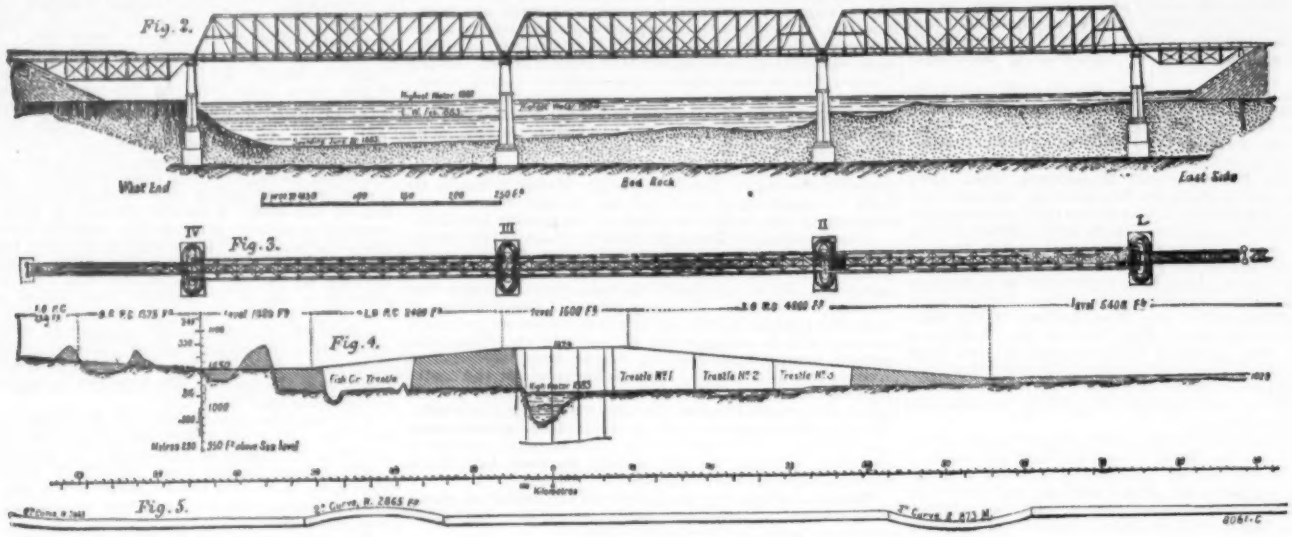
All students in our school can develop the style of work that is to be peculiarly their own. The master can only coax out the ability that is in you. But how much better to help you to become yourself than to train you to carry a borrowed shell. This borrowed shell is a false weight. It will ultimately crush you if you are not strong enough to throw it off. It is misleading to you and to others who watch your progress. In this school you can gauge your strength or your weakness. If you succeed, the success is your own, and means strength to be relied on. If you fail—well, you will know what it means. You will not waste a life in a useless pursuit after a selfish craving, for such it becomes if time and practice have shown that there is not enough natural ability in you to justify prolonged study. You will not add another to the ghastly list of mediocre painters.

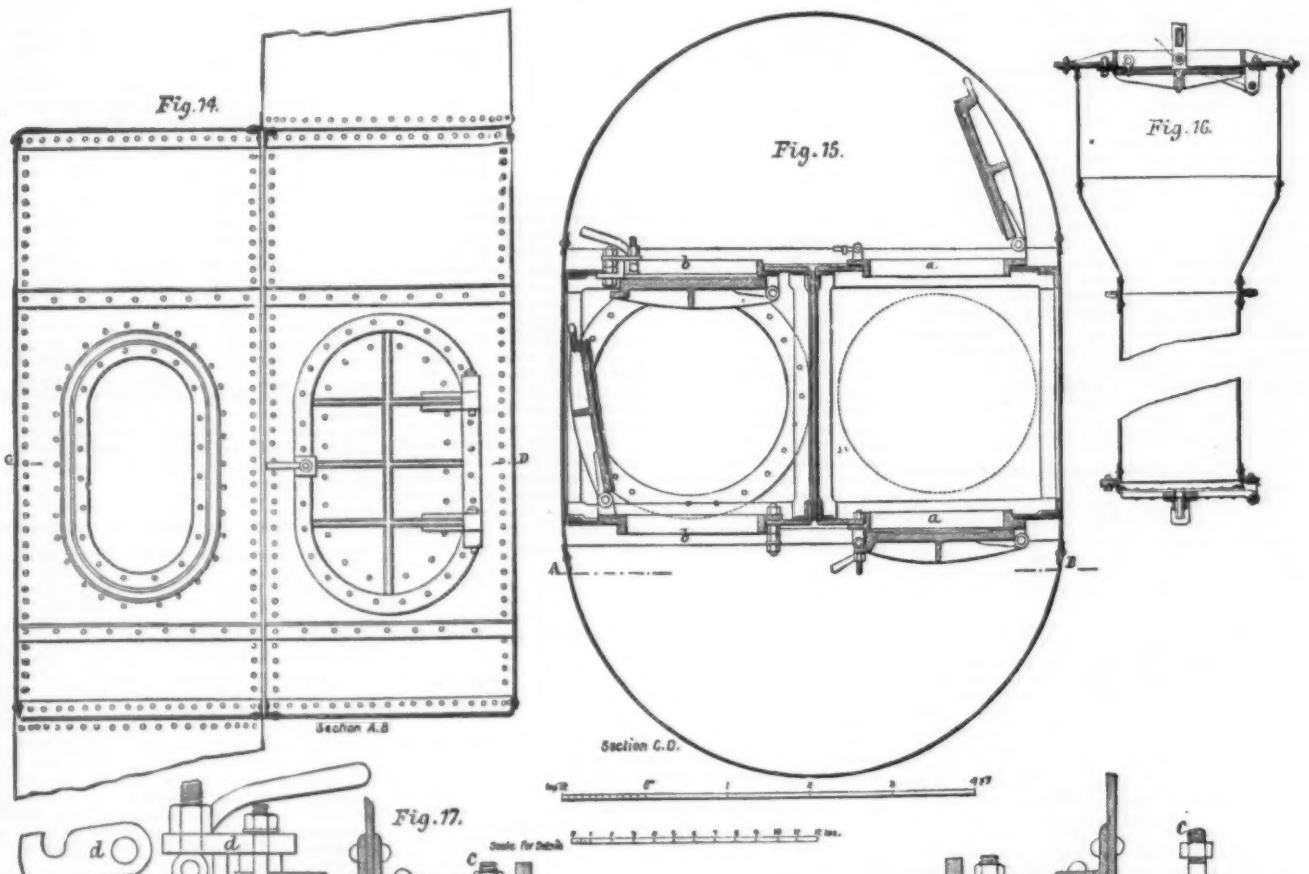
There is other work to do in the world besides painting pictures. But you will be the better men and women for having had a trial with fair and honest means. Therefore, whatever you learn here belongs to you, and becomes part of your own composition. I soon felt how unsatisfactory it was to take only advanced students. It meant getting rid of borrowed shells—shells that I found stick uncommonly fast; or I had to bring to life benumbed identities. But it was often too late, and it was only like galvanizing a lifeless spark.

Therefore the establishment of a preliminary class, under my pupil Wehrschmidt, brought new life to the school. It supplies the life class with students of the right caliber, who have no bad habits to unlearn. I cannot invent a fairer plan of admitting students from this class into the life class than by letting them draw from the nude, and passing then into the life class by their drawings, without knowing who did the drawings. No doubt many are nervous while drawing, and are materially hindered from doing their best under the excitement. But I am perfectly convinced that the artistic tendency and general tenor of the student's mind will be visible in the most nervous drawing. . . . . I have mentioned that students who have left us are coming back. The five studios I have lately built for five of the successful students form the nucleus of the art colony that is growing rapidly in Bushey. And I know no existence more ideal for the young painter than to be in the country, with all its artistic charms to inspire him—with pure air and pure light, combined with an artistic atmosphere—with no cliquish tendency to narrow the society, and yet to be within easy reach of the great center, London.—*Jour. Soc. of Arts.*

## THE BLAIR CROSSING BRIDGE.

WE give illustrations of the railway bridge completed some three years ago by the well-known American engineer, Mr. George S. Morison, of New York. The bridge is the property of the Missouri Valley and Blair Railway and Bridge Company, which also owns a short length of connecting railway, about 3½ miles in length, and which, with the bridge crossing the Missouri, joins the main line of the Sioux City and Pacific Railroad on its eastern and western banks. The bridge crosses the river at a point where, for 18 miles below and for 50 miles above, the high bluffs have disappeared, and the stream, free from their controlling influence, spreads its channel in an uncertain and frequently varying fashion, after the usual manner of great rivers where physical conditions favor the growth of sand bars and the nature of the ground encourages encroachments, developing occasionally into "cut-offs," which wholly change the course of the stream. A general map shows the characteristics of the river at the bridge location at the beginning of 1883. At that time the width was very indefinite, the river was rapidly encroaching




THE BLAIR CROSSING BRIDGE, MISSOURI VALLEY AND BLAIR RAILWAY AND BRIDGE CO., U. S. A.

on the land on the west side, while the large sand bar was divided by a channel, through which a fierce current ran in flood periods. The line selected for the bridge appeared to the engineer to be as convenient as any other that could be chosen, and preliminary borings revealed the presence of bed rock at an unexpectedly small depth, and promised a facility in getting in the foundations that was unlooked for. As there appeared very little reason to fear for the stability of the work, whatever may be the changes in the channel, it was determined to build a bridge with ample waterway to pass the whole volume of the Missouri, and afterward to take such measures as were practicable to maintain the river bed in the position it occupied when the bridge was built. Bearing this object in view, it was determined to construct a bridge 1,000 ft. in length, and with 50 ft. headway between the bottom and ordinary high water level.

The main bridge is divided into three equal spans

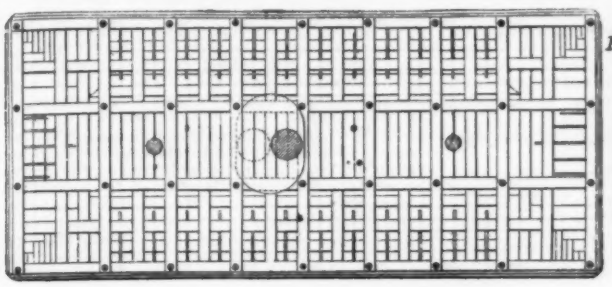


Fig. 6.

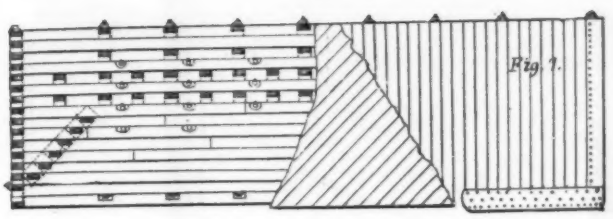


Fig. 7.

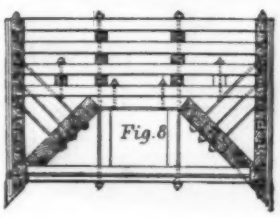


Fig. 8

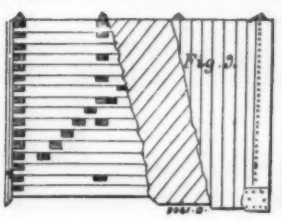


Fig. 9.



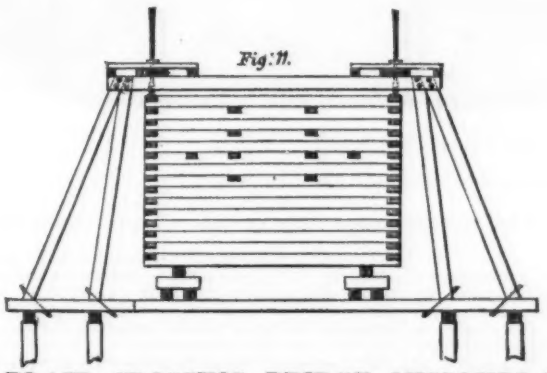


Fig. 11.

sunk to the rock by the plenum-pneumatic process. The foundations were put in by the company's men under the direction of the engineers. The caissons for Piers I. and II. were built on the dry sand bar on the east side of the river. The caisson for Pier III. was built in position on pile false work, and lowered by long screws to the bottom of the river. The caisson for Pier IV. was built in position in a pit excavated to the surface of the water.

The pneumatic machinery was set up on the east side of the river, immediately east of Pier II. It consisted of two No. 4 Clayton duplex compressors, and two No. 10 Cameron pumps to work the Eads sand pump excavators, with the necessary pipe fittings, etc., the power being supplied by three 60 horse power portable boilers. A temporary pile bridge was built across the narrow winter channel, which was made a double track bridge from the east sand bar to Pier III. The north track of this bridge was used as a transfer track for

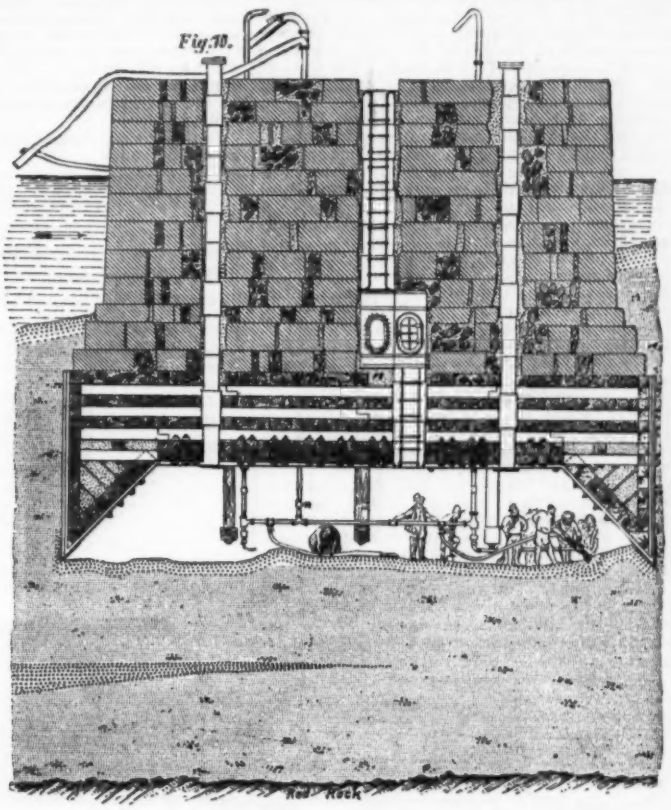


Fig. 10.

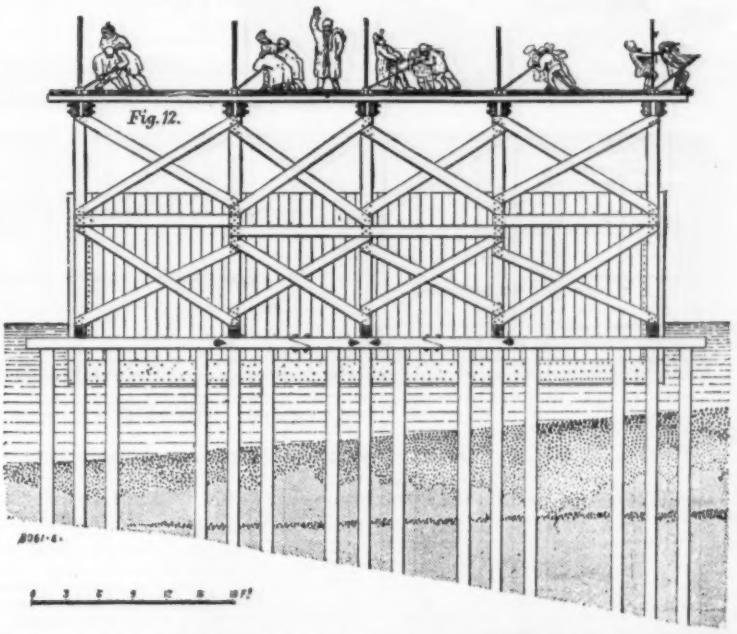


Fig. 12.

THE BLAIR CROSSING BRIDGE, MISSOURI VALLEY AND BLAIR RAILWAY AND BRIDGE CO., U. S. A.

each of 330 ft. between centers of end pins. The distance between the centers of the end piers is 999 ft. At each end of the bridge is a short approach span designed to reach over the embankment. The eastern approach ascends from the level of the rails on the bottom land with a rise of 1 in 100 to the level of the rails on the bridge, and though this approach is now a solid earth embankment, 3,000 ft. of it were originally built in the form of a timber trestle. The western approach is also built as a solid earth embankment, excepting for 1,184 ft., including the crossings of the old Sioux City and Pacific Railroad and of Fish Creek, where a wooden trestle is built with a short Howe truss over the railroad. There is a slight descent from the bridge to Fish Creek, but the Blair station is 30 ft. higher than the rails on the bridge.

To render the course of the river stable at this point, the west bank has been protected by a revetment of brush and stone, this protection above the bridge following a line carefully fixed before the work was begun.

*Substructure* (see Figs. 6 to 12 of our engravings).—The four piers are founded on pneumatic caissons 54 ft. long, 24 ft. wide, and 17 ft. high over all, which were

the general business of the Sioux City and Pacific Railroad, the south track to take material to Pier III. The Cameron pumps were placed on this pile bridge far enough west to have deep water to pump from. The position of the machinery was not changed till the completion of Pier III.

The framing of the caisson for Pier IV. was begun January 23, 1883, and the erection of the caisson in the pit excavated for the purpose was begun February 8. This caisson was completed, including the concrete filling above the working chamber, March 14; the air pressure was put on March 17; the crib work and concrete filling were finished April 2; masonry was begun April 5; the caisson reached the rock April 14; the concrete filling of the working chamber was begun April 17, and finished April 19. The masonry of this pier was completed May 9.

The concrete used was manufactured in a mixer, consisting of a 9 in. spiral conveyer shaft running in a wrought iron trough. Sand and cement were mixed by this mixer, and stone was thrown in after depositing the concrete mortar in position, the stones being thrown in separately by hand. The proportions used were generally as follows: Three of sand to one of cement in the caisson above the working chamber; four of sand to one of cement in the working chamber and in the crib work. Rough stone of irregular size was worked into this concrete mortar, excepting in the filling of the working chamber, which was entirely of concrete. Moreover, the working chamber was first made tight around the edges, and for about a foot over the whole bottom, with a mixture of two of sand to one of cement.

The stone used for masonry was quarried at Mankato, Minn. It is an excellent limestone of yellow color, which has shown evidences of durability in various structures around Mankato. The cutwaters of Piers I. and II. were made of blue granite, quarried near St. Cloud, Minn. The faced stones are laid in Portland cement mortar, and the backing in Milwaukee cement, excepting that in very cold weather Portland cement was used throughout. The total cost of the substructure was $220,328, or about £44,000.

The shore ends of the approach spans were originally carried on Cushing cylinders filled with concrete resting on piles. The pier at the west end settled badly during the grading of the approach. The weight of the approach span was therefore transferred to a crib resting on the embankment, this crib being built up as the settlement continued. In June, 1885, a block of concrete 12 ft. by 24 ft. by 6 ft. was built on the embankment, 66 ft. back of the Cushing pier, and this

MASONRY AND CONCRETE IN PIERS AND FOUNDATIONS.

| | Masonry. | Concrete. | Total. | Cost. |
|---|---|---|---|---|
| East Cushing pier... | 1·7 | 67·2 | 68·9 | $25,519.77 |
| Pier I..... | 1081·7 | 1198·7 | 2280·4 | 36,613.81 |
| Pier II..... | 1562·4 | 589·4 | 2151·8 | 37,882.91 |
| Pier III..... | 1578·9 | 592·3 | 2171·2 | 25,947.13 |
| Pier IV..... | 1108·4 | 1205 6 | 2314 0 | |
| West Cushing Pier (abandoned) ..... | 1·7 | 48·4 | 50·1 | |
| Concrete block..... | 2·4 | 66·7 | 69·1 | |
| Total..... | 5337·2 | 3768·3 | 9105·5 | |

block of concrete now supports the west end of the approach span, which has replaced the shorter span originally built, while the portion of the Cushing pier above ground has been entirely removed. The east Cushing pier remains in its original position, having been pressed forward only a few inches by the building of the embankment.

The superstructure consists of three through spans and two short deck spans in the approaches. The through spans are 330 ft. long between centers of end pins, and the deck spans were 110 ft. long, but the west approach span was subsequently replaced by a 176 ft. span. The entire superstructure was manufactured from designs prepared by the engineer of the bridge, complete shop drawings being furnished to the contractor. On November 6, 1882, a circular was addressed to prominent bridge manufacturers, inviting them to make proposals for the construction of the superstructure. In response to this invitation, five proposals were received. These proposals were opened in New York on December 2, 1882, and the work was awarded to the Keystone Bridge Company, which was the lowest bidder. The trusses of the 330 ft. through spans are divided into fifteen panels of 22 ft. each. They are of the double system Whipple type, with inclined end posts, are 44 ft. deep, and spaced 20 ft. between centers. The top chords, end posts, bolsters, rollers, bearing plates, pins, and the eye bars in the nine central panels of the bottom chords are of steel. All other parts are of wrought iron, excepting the heavy wall plates resting on the masonry, the washers, and the ornamental work, which are of cast iron.

The trusses were not proportioned to carry any particular class of locomotives or cars now in use, but for general conditions, which are believed to include the heaviest class of rolling stock which is ever likely to be used, and to make a provision for the increased effect of a moving load on the central members of the web. The dead load in the long spans was taken at 30,000 lb. per panel. The actual weight of each span, including 450 lb. per foot of timber floor, and rails, was 929,035 lb., equivalent to 30,968 lb. per panel if averaged over the whole bridge. Inasmuch as a portion of this weight is carried directly by the masonry, and as the reduction in weight from the use of steel occurs principally in the central panels, the assumed weight per panel is more nearly correct than the average weight. The moving load provided for in the trusses was 3,000 lb. to the foot, except that, in proportioning the web, the excess of maximum strain in any member over and above the strain in that member under a uniform load of equal intensity was taken on a basis of 5,000 lb. per foot instead of 3,000 lb. The floor system is proportioned for a load of 5,000 lb. per foot throughout. The top lateral system is designed to resist a wind strain of 300 lb. per lineal foot, and the bottom lateral system 500 lb. per lineal foot, the whole being taken as a moving load.

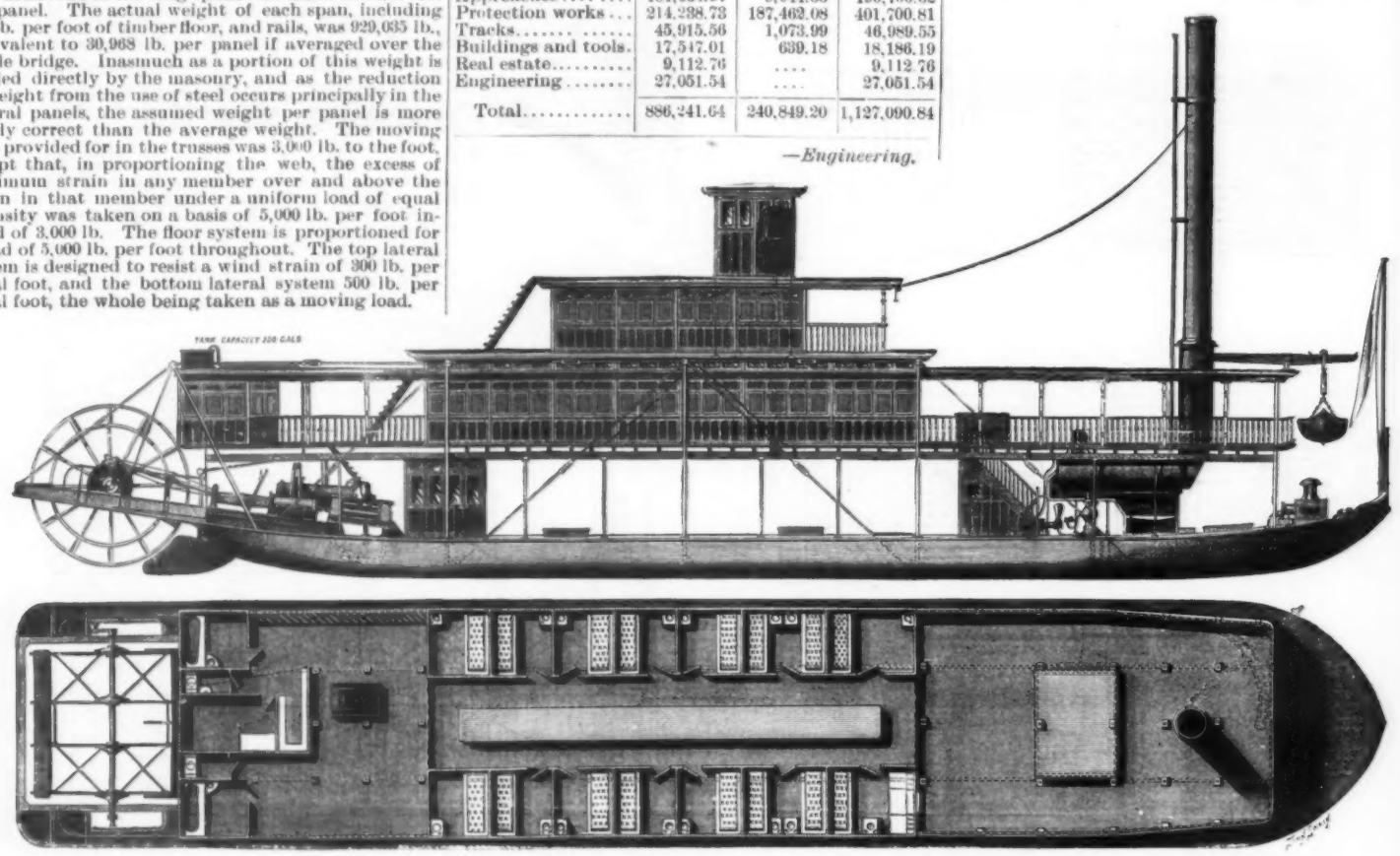
full-sized bars was excellent, the only bars which failed to meet the requirements of the specifications being bars which would have been condemned without the test. The only point in which the specifications were changed was that the required reduction in the samples of tension steel was changed from 45 per cent. to 42 per cent.

The superstructure was erected on staging, consisting of bents reaching to the level of the lower chord, with a large traveler, and without the use of upper false work. The false work under the easterly long span rested on the ground, that under the other two long spans on piles. The floor system consists of 9 by 9 oak ties, generally 12 ft. long, spaced about 15 in. between centers. These ties rest on iron stringers 9 ft. between centers. The track is laid with a 60 lb. steel rail. Inside the rails are placed two lines of 5 in. by 4 in. by ⅝ in. angle irons, bolted to every tie with 1 in. bolts, these angle irons acting as guard rails in case of derailment, and also holding the ties together. A timber ribbon, 10 in. by 10 in., faced 12 ft. over all, is bolted to every fourth tie, and a narrow footway and wire rope handrail complete the floor. The bridge was formally tested in the presence of a committee of engineers, and opened for traffic October 27, 1883, and the old span was taken down and used at the crossing of White River.

The following table gives a summary of the total cost of the work:

| | Cost Exclusive of Freight Charges. | Freight Charges. | Cost Including Freight Charges. |
|---|---|---|---|
| Substructure | $190,383.39 | $36,440.80 | $223,824.19 |
| Superstructure | 200,336.68 | 6,188.80 | 206,525.48 |
| Total, Br'd'e pr'p'r | 390,720.07 | 42,629.60 | 433,349.67 |
| Approaches | 181,655.97 | 9,044.35 | 190,700.32 |
| Protection works | 214,238.73 | 187,462.08 | 401,700.81 |
| Tracks | 45,915.56 | 1,073.99 | 46,989.55 |
| Buildings and tools | 17,547.01 | 639.18 | 18,186.19 |
| Real estate | 9,112.76 | .... | 9,112.76 |
| Engineering | 27,051.54 | .... | 27,051.54 |
| Total | 886,241.64 | 240,849.20 | 1,127,090.84 |

—*Engineering.*



## SHALLOW DRAUGHT STERN WHEEL STEAMER.

Length of hull, 120 ft.; length over all, 139 ft. 6 in.; beam moulded, 24 ft. 6 in.; depth moulded, 4 ft.

The weights of iron and steel in the 330 ft. spans are as follows:

| | Three Spans. | | Average per Span. |
|---|---|---|---|
| | lb. | lb. | lb. |
| Steel | | 884,548 | 294,849 |
| Wrought iron in trusses | 1,012,343 | | |
| Wrought iron in floor | 434,805 | | |
| Total wrought iron | .... | 1,447,148 | 482,383 |
| Cast iron | | 57,322 | 19,107 |
| Total | | 2,389,018 | 796,339 |

The weights of iron and steel in the deck spans are as follows:

| | 110 ft. Span. | 176 ft. Span. |
|---|---|---|
| | lb. | lb. |
| Steel | 4,979 | 6,753 |
| Wrought iron | 110,503 | 238,550 |
| Cast iron | 8,955 | 4,325 |
| Total | 124,437 | 249,628 |

The steel blooms were manufactured by the Cambrian Iron Company, at Pittsburg, Pa., and the steel was rolled by Carnegie Brothers & Co., Limited, at the Union Iron Mills, in Pittsburg. A full record of the tests of sample bars was kept, and fourteen full-sized bars were broken at Watertown. The behavior of these

## STERN WHEEL STEAMER FOR THE RIVER MAGDALENA.

THE Magdalena, like most of the South American rivers, can only be navigated by steamers of exceptionally shallow draught, and yet possessed of high speed, which qualities are essential in consequence of the numerous shallows and tortuous rapids which divide its deeper parts. Stern wheel steamers are specially adapted to overcome these obstacles, as they possess exceptional maneuvering capabilities, far in excess of anything that can be obtained by side wheels, and they can pass through narrow cuts or channels where a side wheeler would inevitably run the risk of seriously damaging its paddles. Moreover, a vessel on the stern wheel principle can be built much lighter than on any other system, because, owing to the heavy weights—*i. e.*, the boiler, engines, and wheel—being at the extreme ends, the hull can be suitably trussed by ties which are in tension, thus obtaining, from a structural point of view, a great depth of hull, while, on the other hand, if the weight of machinery be concentrated amidships, such method of construction is inadmissible, and stiffness can only be secured by greatly strengthening the deck with materials which would be in a state of compression, involving very considerable additional weight, the structural depth of the hull in this case being only represented by the distance between the bottom plating and the deck.

There is a remarkable advantage known to those who have worked sternwheelers, that, in consequence of the position of the wheel, when ascending a strong current or rapid the vessel is enabled to make headway where a sidewheeler possessing the same speed in still water would be unable to contend against the stream. There also seems to be secured by the stern wheel system a greater efficiency, which is possibly due to the reduced slip, owing to the wheel working in a current moving in the same direction as the hull itself, particularly if the wheel is so placed that it acts on the water near or quite at the top of the following wave.

Messrs. Yarrow & Company have constructed sternwheelers for nearly every part of the world, and we hear on all sides of their successful performance. Among those built by this firm our readers will remember the Lotus and Water Lily, which played so important a part in the Nile expedition, and upon which the entire communication between Cairo and the headquarters at Korti depended for several months when all other steamers were found utterly inefficient for maintaining navigation on a river of the character of the Nile, with its numerous rapids, sharp turns, and shallows.

The illustration is sufficiently complete as to require but little by way of description. The hull is 120 ft. long by 24 ft. 6 in. beam, the extreme length over the wheel being 139 ft. 6 in. The horizontal compound surface condensing engines are placed quite aft, as usual, driving the wheel direct, one cylinder acting upon a crank on each side. The air, feed, and circulating pumps are worked direct from prolongations of the piston rods. The boilers are two in number, on the return tubular principle, and are placed well forward, so as to balance the weight of the engines. The system of trussing, by which means the buoyancy of the center of the boat is enabled to support the ends, is also clearly shown. The uprights, or kingposts, serve to carry the decks on which the cabins are placed, thus leaving the main or lower deck entirely free for cargo, which is not usually stowed below, partly on account of the expense and delay in raising and lowering it, but chiefly to leave the entire interior of the hull free, so that in case of damage by running against snags or rocks, it is immediately accessible for repairs.

The hull is subdivided by eight cross and one longitudinal bulkhead, making a total of eighteen watertight compartments. This subdivision is sufficient that, in the event of two or three compartments being damaged, causing serious leakage, the safety of the boat will not be endangered.

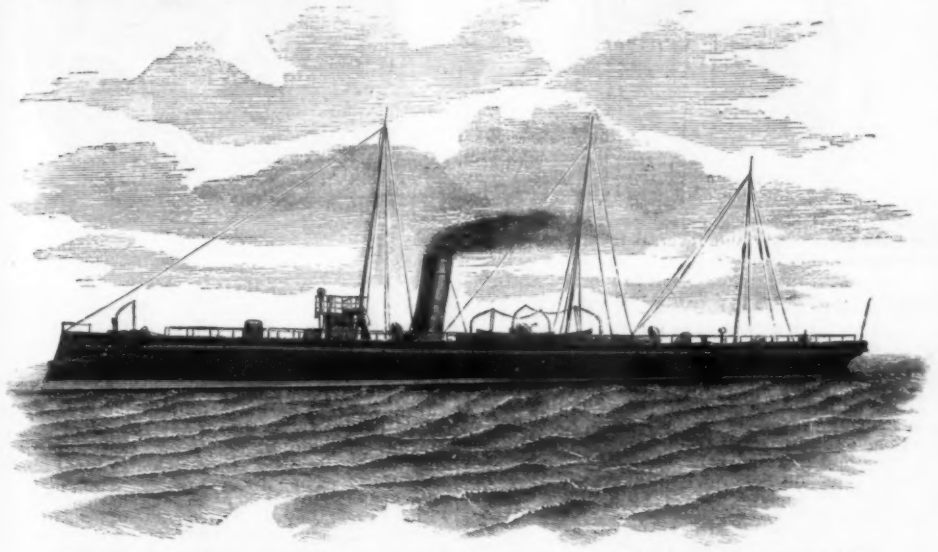
The steering wheel is placed in the pilot house, as shown, at a considerable elevation, so as to enable the man in charge to get a good all round view. From this pilot house are actuated three rudders placed immediately in front of the paddle wheel and between it and the stern. These rudders being balanced do not involve any considerable amount of power to work them; and in consequence of the bow and the stern below the water line being well cut away, and the rudders being of exceptional size, it is easily understood why these boats should steer remarkably well. At the bow there is a powerful steam capstan, especially adapted not only for general use, but also for hauling the boat off sand banks when necessity requires. The accommodation for first-class passengers consists of a main saloon 50 ft. long, and leading out of it are fourteen staterooms, fitted up in the usual style, and arranged so as to secure a good current of air from end to end.

The officers' quarters are on the second deck, immediately below the pilot house, and it will be seen that the saloon deck offers for the passengers a well sheltered promenade. The speed of this boat, judging from previous experience of nearly similar craft, will be fourteen miles an hour on a draught of about 16 in., a very satisfactory performance we need scarcely say.—*The Engineer.*

## THE AUSTRO-HUNGARIAN TORPEDO CATCHER METEOR.

THE accompanying illustration represents a vessel, 57 meters in length and 6·8 meters in breadth, recently built by Herr F. Schichau, of Elbing, for the Austro-Hungarian government, and specially designed to allow of her attaining the highest speed when required to chase torpedo craft. The vessel, which made her final trial on the 25th of August, is now lying in the open sea off Pillau, with full war equipment on board, and carrying coals for a run of 2,600 nautical miles at a mean speed of ten knots.

The speed during the one hour's trial, and against a wind with a pressure of 4, was equivalent to an average throughout of 23·1 knots, 26·6 statute miles. The vessel, when loaded, has a displacement of 420 tons, and the capacity of her bunkers enables her to carry coal sufficient to supply the highly economical type of engines with which she is fitted (and for which her builder is celebrated) for a run of 6,500 nautical miles without recoaling, a most highly satisfactory state of things, and equaled by few, if any, vessels of her class.



THE AUSTRO-HUNGARIAN TORPEDO CATCHER METEOR.

The boiler and engines are entirely protected by the coal bunkers, these being also supplemented by steel armor, and when running at full speed no vibration is perceptible; in fact, the vessel is perfectly steady, and no head waves are created, two most valuable qualifications from a gun platform and marksman's point of view.

The combustion in the boiler is excellent, Schichau's patent furnace being used, a system which permits of the stokers working in fresh air; in fact, during the trial the skylights were opened It is also worthy of notice that with this system, and when running under forced draught, very little smoke escapes through the funnel, and then only on rare occasions.

The engines worked absolutely without fault, both during the trip of one hour and the forced draught trial of four hours; the Imperial Austrian Commission who subsequently took the vessel over expressing admiration with its performances throughout.

The Meteor, which from our illustration will be seen to present a far more pleasing and symmetrical appearance than generally obtains with this class of vessel, makes, when having coal on board for a run of 1,000 nautical miles, twenty-five knots, by the measured mile, and will be, by the time this is published, homeward bound for Pola with an Austrian crew on board. —*Marine Engineer.*

## CASTINGS IN METAL FROM CARBONIZED FABRICS.*

THE Sub-Committee of the Committee on Science and the Arts, of the Franklin Institute, to which was referred, for examination, Mr. A. E. Outerbridge's method of carbonizing fabrics and casting therefrom, reports that Mr. Outerbridge's invention consists essentially in the preparation of organic textile fabrics, such as cloth and lace, and the natural organic structures of ferns, grasses, and the leaves of plants, so that they can be exposed to very high heats without causing a disturbance of their form by destructive distillation.

The material which has been subjected to this process becomes capable of resisting the action of the heat from molten cast iron, and may be used as a part of the surface, or facing, of a mould, for the purpose of producing an intaglio impression of the material in cast iron, or other metal, and which casting can be employed, in the manner of a die, for the purpose of reproducing the design or figure upon leather, wood, or metal

The material to be used as a pattern, or mould, is first dusted with finely powdered carbon, and then packed in finely ground carbon within a refractory case, made of cast iron, graphite, clay, or other suitable material. This case is fitted with a lid sufficiently close to prevent such free access of air as would allow of combustion, but which is loose enough to permit the escape of the vapors and gases which are produced by the after treatment.

The case and contents are then placed in an oven, and subjected to a temperature of about 300° F. for several hours, until the escape of volatile matters from the case has ceased.

The case is then removed from the oven, placed in a suitable furnace or forge, and the temperature gradually raised to and kept at a glowing heat for about two hours, after which it is removed from the fire and cooled.

When the contents are taken out of the box, they are shaken in order to remove the carbon with which they were dusted, and in which they were packed. They are then tested by heating to a white heat in a blast lamp flame, and, if combustion ceases upon their removal from the flame, the operation of carbonization has been properly conducted, and they are suitable for use as moulds or facings of moulds for metal castings.

The success of the method of preparation consists in first removing the fluid or liquid parts of the structure operated upon, and then so slowly distilling off those constituents which are produced by destructive distillation that the carbonaceous parts, which are unaffected by the heat, and the integrity of the fibers or structure of the fabric, shall not be disturbed by the too tumultuous exit of the vapors and gases; the exceedingly high temperature at the close of the treatment insuring the complete expulsion of all volatilizable matter.

The difference of result obtained by heating organic structures from ordinary to high temperature, rapidly or slowly, to expel volatilizable parts, is well shown in the difference in the structure of cokes produced from ordinary bituminous coals in gas retorts and that from the same coal in coke ovens.

Gas coke, which is made by rapidly heating the coal, is in the form of a spongy, porous mass, weak in structure, insonorous, easily ignited, and having the appearance of a mass from which bubbles of gaseous matters have escaped.

Oven coke, which is made by heating comparatively large bodies of coal gradually and continuously for a long period, is of a close-grained structure, capable of sustaining great pressure or weight, and so compact and dense that it is sonorous. This coke is far more difficult to ignite than the gas coke, and somewhat resembles graphite in its characteristics.

The fact that nearly pure carbon, which is with difficulty ignited, and having the ring of steel, can be produced from wood, flax, hemp, cotton, paper, or silk, by heating them to redness out of access of air in a carbon vapor, or embedded in powdered charcoal, has long been known.

The committee has no knowledge of any other method of carbonization whereby the form or integrity of the structure of fabrics, either natural or artificial, can be preserved intact.

That the product of the method of treatment of organic structure by Mr. Outerbridge is a mixture of pure carbon with a silicious ash is evident from the results of analysis.

A piece of ordinary muslin untreated yielded of—

| | |
|---|---|
| Moisture | 3·05 per cent. |
| Ash | 1·53 " |

A part of the same strip of material when carbonized by Mr. Outerbridge's method weighed 34·26 per cent. of the untreated stuff, and it contained ninety-five per cent. of carbon. From these results, it appears that 65·74 per cent. of the original material was given off as water, vapors, and gases. This carbonaceous residue was consumed with difficulty by the action of strong oxidizing agents, such as chromic and sulphuric acids, and required the use of a very high temperature, with free access of air, to burn it in the determination of an ash, which amounted in weight to 4·43 per cent. of the treated material.

The treatment has then converted an easily ignitible material into one exceedingly difficult of ignition, and the method employed has secured at the same time a preservation of the integrity of structure with but slight diminution of dimensions.

The change in the properties of the carbonaceous residue from fabrics, by which it resists the action of highly heated metal, similarly with graphite or graphitic carbon, permits the use of woven or natural fabrics as moulds, for the cheap reproduction in metal of designs which could not otherwise be made, except at enormous expense for engraving.

The method of using the prepared fabric as a mould is very simple. When it is desired to pour the metal over it, the ends of material are fastened down, either by the edges of the flask or by pinning, and the gates arranged so that the metal shall flow over and not fall upon it. When the side of the block of metal is to receive the impression, the fabric is secured at the lower edge, and it is floated against the side by the inflowing metal.

When the treated fabric is brought in contact with melted cast iron, there appears to be no more tendency to absorption than there is with graphite. Several members of the committee were present when the exhibit accompanying this report was made in white cast iron.

The committee is informed that the most delicate fabric, such as a lace veil of fine mesh, can be stretched across a mould, and (if the metal be poured so as to rise equally upon both sides of it) that it will remain intact, and when the metal becomes cold, a parting of the metal will be made upon the line of the dividing "veiling," each part having impressed upon it an intaglio image of the fabric.

Paper and cardboard treated by this method have been employed to divide the metal in a casting, where it has been desirable to do so, for instance, to break the continuity of the metal in the circumference of a circular casting, and thus diminish or prevent the strain otherwise produced upon the internal parts in casting.

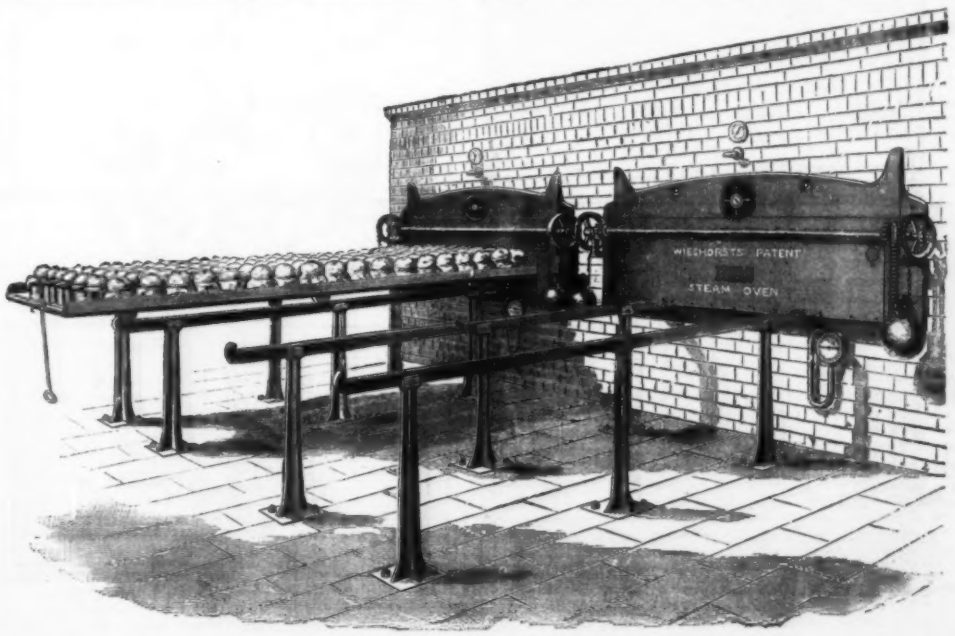
The application in the arts of the invention of Mr. A. E. Outerbridge is at present limited to the cheap production of elaborate designs for the ornamentation of castings, or for the production of dies for embossing leather, paper, or metallic surfaces, and also for the easy parting or dividing of metal in casting; but new fields of application will undoubtedly be opened when the method is brought into more general use.

The committee considers that the process devised by Mr. Outerbridge is of sufficient importance in the arts to warrant an award for meritorious invention. The John Scott legacy medal and premium was awarded. —*Jour. Fr. Inst.*

* See SUPPLEMENT, No. 601, page 9596.

## IMPROVED STEAM OVEN.

WE give an illustration representing a "Wieghorst" steam oven, for the use of bakers, confectioners, bread manufacturers, or millers who bake any quantity of bread for the public. This oven, which, as will be seen by referring to the illustration, is fitted with a traveling or withdrawable baking plate for bread, cakes, or biscuits, is heated by means of pipes, entirely closed at both ends, and partly filled with water, placed at the bottom and top of the baking chamber, thus forming regular heat-radiating strata. The heat required in the baking chamber is produced by the water in the sealed pipes being heated and steam generated from the ends of the pipes protruding into the fire. The soot, which will cover by degrees the ends of the sealed pipes entering into the fire box, and, as a non-conductor, will prevent a quick communication of the heat developed in the fire box, is taken off through doors arranged in such a manner as to make the ends of the pipes easily accessible. The chief advantages claimed as attending the use of these ovens are the great saving of time and labor, and uniform baking, which is the result of the whole batch being introduced into, and drawn from, the oven at once. The traveling or with-




IMPROVED PATENT STEAM OVEN.

drawable baking plate is one of the best mechanical means of putting ("setting" the bread) the dough loaves in the oven and withdrawing the bread loaves when baked. The traveling plate, by means of small wheels, runs very easily on rails in and out of the oven, the rails being fixed at the bottom of the baking chamber, over the bed of sealed pipes, and at the oven door, as shown in our illustration. The door of the baking chamber, which has, fixed at each end, a rack, into which gears a pinion or small cog wheel, is opened and closed by means of a small shaft and counterweights. The cog wheels are fixed on the shaft, which is rotated by means of the counterweight. These are suspended from chains, which act on the shaft through chain wheels on pulleys, over which they are slung, as shown in the illustration.

The engraving represents two "Wieghorst" patent steam ovens, as supplied to Mr. T. Fletcher, of Birmingham (president of the National Association of Master Bakers and Confectioners), and fitted up in his bakery. Some of our readers will no doubt remember seeing this oven in operation when they visited, on the morning of Wednesday, the 23d of February last, on the occasion of the first meeting of the National Association of Master Bakers and Confectioners, the remodeled bread and cake bakery of Mr. Thomas Fletcher, at the special invitation of that gentleman. The most imposing feature in Mr. Fletcher's bakery was two "Wieghorst" patent steam ovens, which faced the visitors as they entered the bakery. Instead of the man having to stand for fifteen or more minutes in the heat, manipulating his peel, the plate is withdrawn in half a minute, and a boy can then remove the loaves. Mr. Fletcher's strong argument in favor of these ovens, visitors will remember, was that every loaf was equally baked, and the reason why Mr. Fletcher preferred this patent oven over the ordinary oven was that the first loaf was not left until those put in last (and consequently much less baked) are withdrawn. The two ovens, as shown in the illustration, have each a baking plate of 10 ft. 6 in. by 5 ft. 9 in., and are capable of turning out, we believe, eight or nine batches of 200 two lb. loaves in twelve hours.—*The Miller.*

## IMPROVED DUPLEX GAS GENERATOR.

THE new Thwaite duplex producer (of which Fig. 1 is a section through M M in Fig. 3, Fig. 2 a front elevation, Fig. 3 a sectional plan at C C in Fig. 1, Fig. 4 a similar plan through N N, and Fig. 5 a sectional view of gas regulating valve, J) is intended to manufacture a gas akin to what is sometimes termed water gas, or a gas having about equal volumes of carbon monoxide and hydrogen. In the duplex producer one of its gas generators is producing ordinary carbon monoxide gas as in the twin producer, while water gas is being simultaneously produced in the other, the gases from both generators being thoroughly mixed in the process of production.

The chemical action is stated to be as follows: In one generator the fuel is oxidized by the air to $CO_2$, and this gas on passing through the superincumbent fuel is converted into CO, thus $CO_2 + N_2 + C = 2CO + N_2$. The reaction in the second generator is said to be $2H_2O + 2C = 4H + CO_2 + C = 4H + 2CO$. To this product is added the gas from the first reaction, so that the duplex producer gas consists of the following constituents: $4CO + N + 4H$.

The mode of production is as follows: The coal, lignite, slack, or other carbonaceous fuel in one generator, A, is heated up to the condition of incandescence by aspiration of the steam jet, C. The fuel in the other generator, B, is already in a condition of incandescence by a former period of oxidation. The volatile gases evolved in the generator, A, are aspired along with the CO by the steam jet, C, and forced descensionally through the incandescent fuel in the generator, B, and are thus rendered permanent. The operation is continued until the entire fuel in the generator, A, is raised to incandescence. Then the valve, D, is reversed, and along with it the steam valve, E, the gases escaping by the flue, F. When the gas is required to be of a higher thermic quality, liquid hydrocarbon is aspired along with the steam. The air for partial oxidation is heated by being drawn through hollow tubes, H, which form the floors of the gas generator. The gases escape along a cast iron refractory lined main pipe, and the

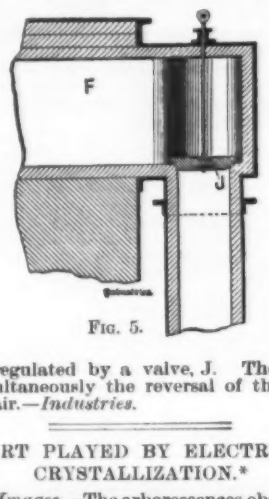



FIG. 5.

supply is regulated by a valve, J. The handle, K, effects simultaneously the reversal of the currents of steam and air.—*Industries.*

## THE PART PLAYED BY ELECTRICITY IN CRYSTALLIZATION.*

*Negative Images.*—The arborescences observed under the microscope give ordinary images that may be called positive. Being opaque and seen by transmission, or rather by light from beneath, they appear black upon the white ground of the field. But, if we illuminate them obliquely, or if we turn the mirror so that it does not send reflected rays, or simply pass our hand in front of the mirror so as to intercept a part of the light, then the images will be white upon a black ground, such as in photography are called negatives.

When the solution used is thick, the arborizations occupy the crests of these species of chains of Liliputian mountains, with black summits in the positive images and white in the negative ones.

This last named mode of illuminating the negative images offers some advantages over the preceding. The use of it permits of distinguishing the details and relief better, the eye not being dazzled by the light concentrated in the field. Consequently, it is less fatiguing in observations of somewhat long duration, or in frequently repeated ones.

*Repulsion of Arborizations emanating from Neighboring Centers.*—For the purpose of diminishing the rapidity of the crystallization and rendering the phenomenon visible in its different phases, it has occurred to me to add a certain quantity of gum to the solution. The speed of formation of the arborizations was rendered somewhat slower, and the length of the ramifications diminished, but another phenomenon occurs that has a peculiar interest to us: Upon the liquid film strewed with zinc filings, the arborizations emanating from neighboring centers very perceptibly repulse each other, and the crystallizations are clearly arrested or are bent opposite each other, whatever be the proximity of the filings strewed in profusion over the entire extent of the liquid film. (Fig. 15.)

This repulsion between arborescences emanating from neighboring centers was but slightly marked in solutions without gum, while it became striking in all more or less gummy solutions of different natures. The fact, then, is general.

It must not be supposed that the intervals observed

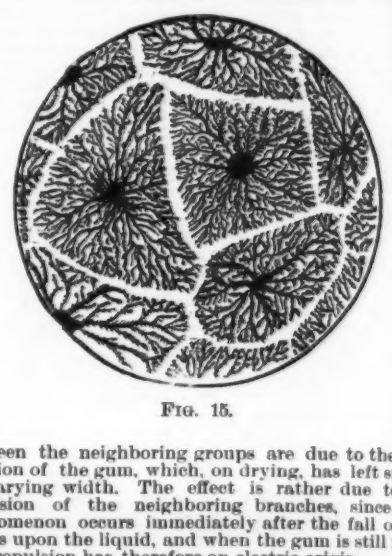


FIG. 15.

between the neighboring groups are due to the contraction of the gum, which, on drying, has left spaces of varying width. The effect is rather due to the repulsion of the neighboring branches, since the phenomenon occurs immediately after the fall of the filings upon the liquid, and when the gum is still fluid. The repulsion has therefore an electric origin.

If, in order to facilitate the adhesion of the liquid to the plate of glass (a thing not very easy to do with an aqueous solution), we add a very small quantity of gum water, the arborescences change their character completely. They become slender, angular, long-branched, and arranged at various sharp angles, while, without gum, they are, with acetate of lead, in the form of stars composed of numerous rays in the shape of sharp spears bristling with points at right angles.

If, instead of mixing gum with the solution, we rub

FIG. 16.

the glass plate with a bit of cork slightly moistened with gum water, we obtain stellate arborescences of very great delicacy, but with slightly curved angular branches, like those of the silver under the before cited conditions.

Between the metallic arborizations in course of formation under the microscope, in any liquid, and the same arborizations definitely fixed upon a dry glass plate, there is an immense difference. The first are very sharp and extremely delicate, while the second are confused, their points and edges are dull, and the fine primitive ramifications have disappeared. This is the cause of this transformation, this difference, this alteration: In measure as the arborizations develop, their bulk increases, and the small metallic crystalline needles near each other finally touch each other and form fascicles, or more or less compact brushes or feathers, in which we no longer distinguish the fine, delicate needles which were visible at the time of their

FIG. 16 BIS

formation, so that, when the arborizations have taken on their development in the peculiar conditions of the experiment, they have lost much of their distinctness and of their first form.

Moreover, the saline crystallizations clog up the arborizations and render them unrecognizable. This effect is so much the more marked the more concentrated the solution is. That is why it is not possible to preserve the arborization intact upon the glass plates.

This trouble is partially overcome by causing the liquid (at least the greater part of it) to flow off after a sufficient development of the arborizations and before they become clogged up.

In order to see the arborizations in all their beauty, it is therefore necessary to observe them at the moment

* Continued from SUPPLEMENT, No. 618, page 9871.

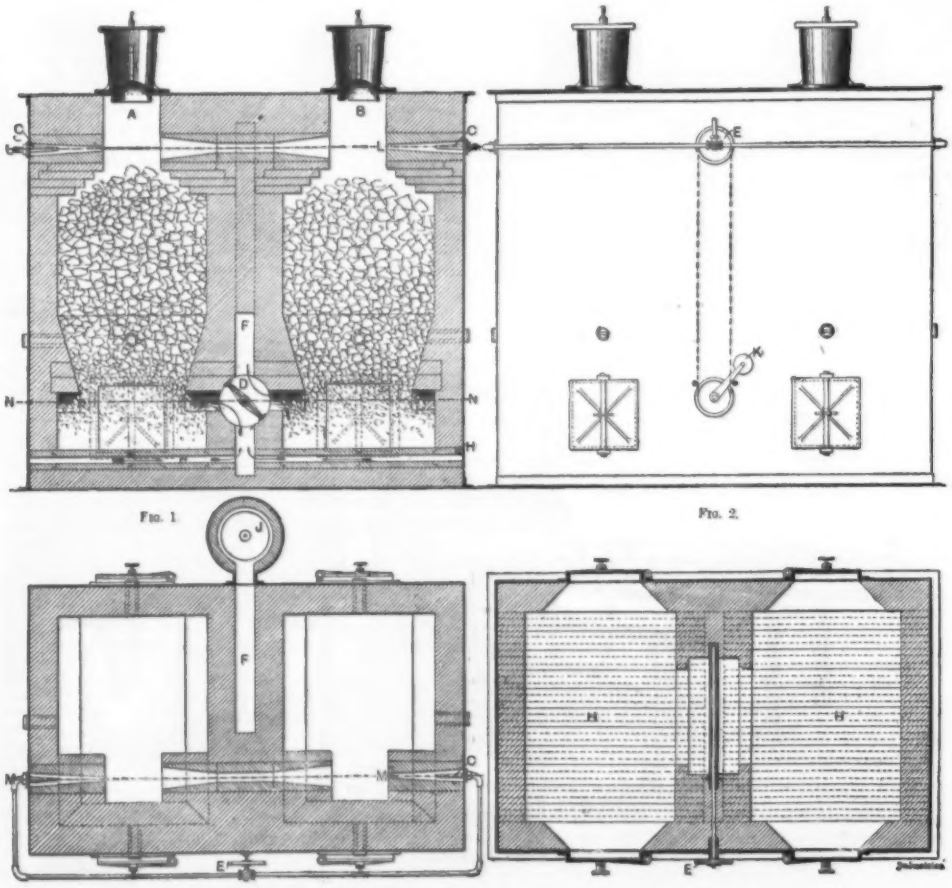



FIG. 1. FIG. 2. FIG. 3. FIG. 4.

IMPROVED DUPLEX GAS GENERATOR.

they develop. This is the only way to observe all the delicacy of their varied arrangements.

Let us now describe the arborizations peculiar to each solution and to the various experimental conditions.

1. *Arborizations of Silver.*—When the solution of nitrate of silver is concentrated enough, the arborizations are, so to speak, instantaneous, and are somewhat thick, especially at the base (Figs. 15 and 16). If the solution is dilute, they are more delicate, and, at their extremities, spread out in very fine tufts, invisible to the naked eye (Fig. 16 *bis*). Finally, with a very

FIG. 16 TER.

dilute solution the arborizations are slower in forming, and remain slender, their branches dividing less into branchlets. Nevertheless, a few silken tufts form at their extremities (Fig. 16 *ter*). To what we have said in general of solutions mixed with gum we have nothing special to add with respect to the silver solution.

2. *Arborizations of Lead.*—These are very curious to observe. With a concentrated solution of acetate of lead, they resemble stars formed of from 20 to 25 rays around each filing (Fig. 14). At right angles with these rays there form brilliant crystals, whose lengths continue to diminish in measure as they approach the extremities, thus giving the whole the aspect of ships' masts with numerous yards on which

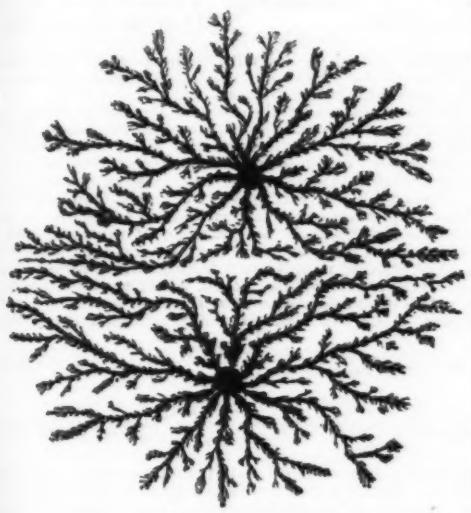


FIG. 16 QUATER.

sailors are standing, or the appearance of fir trees with their branches at right angles with the trunk. Those arborizations that develop in less than three seconds are very beautiful and very brilliant, and after this, as we have before said, they lose their distinctness.

If the solution is highly concentrated, in a thin film, and if the filings are close enough to each other, the crystallization is truly instantaneous, and the crystals are so massed that all that is seen in the field of the microscope resembles a bundle of dry spines.

With a dilute solution, the ramifications, although starting from the same center, no longer radiate in straight lines, but affect forms analogous to those of

FIG. 19.

more or less sinuous branches of trees, with crystals running more or less obliquely (Fig. 19). But what especially distinguishes these arborizations from the preceding is that at their extremities, and with relative slowness, they spread out into the form of a peacock's tail (Fig. 19 *bis*). It might be thought that these were the white crystals that follow the metallic crystallization; but this is not the case. Finally, if the solution is extremely dilute, the arborizations are delicate, and few in number around each filing, and often resemble spiders' legs (Fig. 19 *ter*). When gum is added to the solution, the vegetations are delicate, slow, and not well developed.

*Arborizations of Copper.*—These sensibly differ from the preceding by their forms being clogged up from the base to the extremity of the branches (Figs. 11 *bis* and 20). They have an analogy with the arborizations of the sulphide of iron found in slate quarries. With a somewhat concentrated solution of sulphate of copper, the arborizations are analogous to branches of heaths (Fig. 20).

The vegetation is so rapid under these circumstances that the white filings of zinc, on falling upon the liquid film, at once change into red arborizations of reduced copper, visible to the naked eye.

FIG. 19 BIS.

In measure as the solution is diluted, the vegetation becomes thinner. With a certain degree of dilution, there forms, after the ordinary compact arborizations, other external and very delicate ramifications, in tufts analogous to those that we have described on the subject of silver and lead, but much finer, handsomer, and more abundant with the copper solution (Fig. 20 *bis*: × 20).

On adding gum to the copper solution, we obtain effects corresponding to those that have already been described.

If the solution, while containing a certain quantity of gum that renders it thick, contains but little copper salt, the arborizations form with difficulty, and remain imperfect or amorphous.

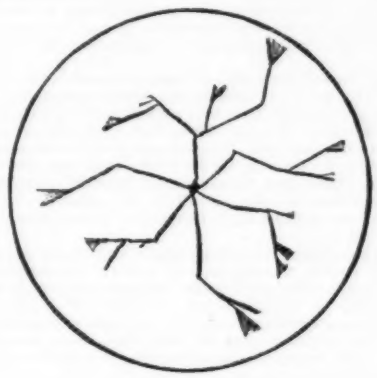


FIG. 19 TER.

It is to be remarked that the copper laid bare in well developed crystallizations loses its red color in a few hours, and becomes of a dark brown. In a few particular cases, with quite dilute solutions, arborizations of lead or copper are produced in stars with hollow center, or in crowns, that is to say, where the zinc filings, after bringing about the formation of arborescences, disappear completely (Figs. 21 and 21 *bis*). After the exhaustion of the precipitant metal, the ramifications of the precipitated metal are repelled as if charged with the same electricity.

To the names of the authors whom we have already cited on the subject under consideration must be added that of Mr. Righi.

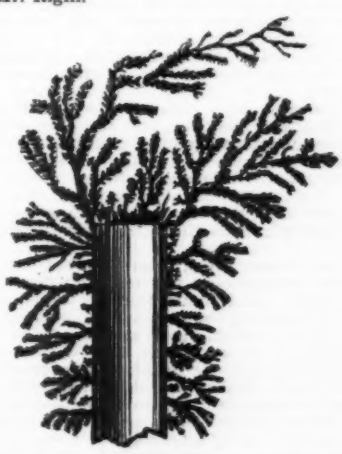


FIG. 20.

As well known, the phenomenon of the tree of Mars is produced by throwing a few crystals of sulphate of iron into a solution of silicate of potash. Upon each crystal there form arborescences in nearly vertical needles. Mr. Righi has explained the formation and arrangement of these needles and the role of the gas bubbles that are produced in certain cases. Messrs. Mure & Clamont have obtained analogous arborescences with sulphates of copper, zinc, manganese, and cadmium, and nitrates of lime and silver, and always using the silicate of potash.

*Application.*—On seeing with what rapidity the metallic crystals form with the aid of a few zinc filings strewed upon a thin film of a saline solution, and in remarking how easy it is to distinguish arborizations of different natures from each other, it at once occurs that it is possible to make an application of these results for ascertaining in a given solution the presence of one of the precipitated metals; in a word, to make of it a means of qualitative analysis. To this effect, we should prepare some test objects that would serve indefinitely as a term of comparison for various more or less dilute solutions.

By this means we might even judge, through the rapidity with which the arborizations form, whether the solution was more or less rich in such or such a metal. It would be possible, too, to form test objects from mixtures of saline solutions having no chemical action

FIG. 20 BIS.

upon each other. These means would constitute a simple method of rapid analysis with a small microscope or a lens.

The instantaneous production of metallic vegetations, as well as that of electrolytic arborizations, furnishes a means of performing extemporaneous experiments with the solar microscope in lecture courses. The spectacle of these beautiful crystallizations, which rapidly throw out branches on every side, is one that greatly interests those who are witnesses of it.

Before leaving this subject, we must point out the analogy that exists between the forms of the dendrites

FIG. 21.

already described and those of another origin and nature, that are found in agates. We say *in* agates, for the metallic infiltrations that determined these dendrites have penetrated the mass of these stones through microscopic fissures, so that the agates can be sawed and polished without destroying the dendrites, which are often very pretty. Let us add, however, that the name dendrites is more particularly given to such arborizations as are merely superficial, while the name arborizations is often applied to such as are internal.

Finally, we may remark that the sulphate of iron

FIG. 21 BIS.

arborizations frequently found in the Angers slate quarries affect forms that nearly approach those of fossil plants, with which they have often been confounded.—*C. Decharme, in La Lumière Electrique.*

## DANGER FROM LIGHTNING.

By Prof. A. E. DOLBEAR.

FRANKLIN'S experiment with the kite, together with the observed effects of knobs and points upon electrically charged bodies, led quickly to the proposal of lightning rods for the protection of houses from lightning. Pointed conductors reaching above the highest parts of the building, and continued into damp earth, were to furnish a means of discharging an electrified cloud by preventing electric accumulation in the cloud and the consequent lightning. If, however, there was to be a discharge at that place, the rod, being a better conductor than the material of which the house was built, was supposed to induce the discharge through it, and thus protect the house. This has been found to be true, but not the whole truth, for it has been found that, to insure protection, every exposed point high and low must have its rod, and that more attention needs to be given to the underground part of the rod and the character of the ground in which it is embedded. Many buildings have been struck by lightning

that have been provided with rods that externally appeared to be everything requisite, but underground they have been found to be too short, and ending in dry earth or gravel but a foot or two below the surface. To be sure, the rules all call for the rod to end in a well of water or in earth always damp; and to secure this in places charcoal has been recommended as a proper material to surround the rod in the ground, as it is supposed to absorb and retain moisture.

With the knowledge we possess to-day, it is easy to understand that no amount of charcoal will be of service if the charcoal itself be in dry earth. A house with a poorly constructed rod upon it is in more danger than it would be without it. I knew of a house provided with a rod which was raised up to put another story under it. The rod was pulled out of the ground and the lower end left dangling in the air six or eight feet from the earth. While in that condition the lightning struck it and did considerable damage to the building. Formerly all lightning rods were fixed upon insulators upon the building; now such provisions are discarded as quite useless, and the rod is made fast in the most direct way to the part to be protected. The wetted surface of buildings furnishes ample conductivity to electricity of the high potential of lightning. It was once thought that lightning rods should be made of large surface rather than large cross sections, and the changes have been rung on that idea. Hollow rods, strips, straps, twists, and braids, and these made of copper or iron or steel, painted or galvanized, have been put upon houses by enterprising lightning rod men, glibly quoting Sir Snow Harris and Prof. Henry. It has, however, long been known that conductivity is what is wanted, and not area, and Prof. Carhart has demonstrated that Prof. Henry's conclusions were wrong. Conductivity can be secured with either iron or copper. I have seen miles of telegraph poles that have been struck by lightning, but I do not remember to have ever seen a No. 8 telegraph wire that has been fused by lightning. Possibly it may have been in some instances, and in my judgment a No. 4 telegraph wire of iron has conductivity sufficient for the protection of any ordinary building if its ground connection is properly made.

Whatever may be the source of atmospheric electricity, it should be remembered that, whenever it is generated, there is practically an area of cloud and of earth between which there is a difference in electric potential. Sometimes the areas are large, and then it is not the contour of the ground that determines where the discharge shall take place so much as the conductivity of the earth itself within the region of the electrical action. If there were a hill made of glass or of hard rubber, and there were buildings and trees upon it, it is not in the least degree probable that either would be in the least degree in danger from lightning, for the difference in potential could never rise high enough to discharge through it, and there could be no discharge into it any more than into any insulator.

The principle of least work holds for electricity as in other forms of energy, and the discharge would take place, if at all, to another field of ordinary conducting earth one, two, or more miles away, as offering less resistance, and therefore requiring less work than the destruction of a quarter of a mile of glass. It is familiar enough to every observer that lightning seldom goes vertically to the ground. It generally takes the hypotenuse of the triangle rather than the perpendicular. That it does so over large bodies of water I have no knowledge. I should expect it would not, but would in every case go vertically into the water. If any one knows of its being otherwise, I should like to know of it. There are some kinds of trees that are more often struck by lightning than others. For instance, poplars and locusts seem to be more subject to lightning than many others as common, while beeches are seldom or never struck. It is possible that these peculiarities may be due to the difference in the distribution of their roots, some trees having surface roots covering a large area of ground, while others go deeper with tap-like roots. One of these would discharge a large area, while the other could not. But there are some areas of considerable extent that appear to be not subject to lightning, while others are frequently struck. On mountains above tree level the lightning does not strike the mountain, but goes between clouds. It is plain that there can be no distribution through rocks, and hence one might expect that there would be hills on a lower level which would be less likely to be visited by lightning than others on account of their rocky foundations, and hence houses built upon such eminences would be more secure without lightning rods than others on a better conducting surface would be with them. Thunder showers generally follow water courses through valleys, unless they are extensive enough to cover a large area, and then the destructive effects are generally in the lower lands and not on hills. This is the same as saying that the storms follow the areas of country of highest conductivity, and do their minimum of work in sections of high resistance.—*Practical Electricity.*

## ON A PARTIAL SEPARATION OF THE CONSTITUENTS OF A SOLUTION DURING EXPANSION BY RISE OF TEMPERATURE.*

By Prof. J. W. MALLET, F.R.S.

IT was observed in regard to a thermometer containing colored alcohol, the color due probably to cochineal, that on several occasions when rise of temperature occurred somewhat gradually in the room after rather severely cold weather, the upper part of the column of liquid was colorless or nearly so, while no deposition of any solid coloring matter could be seen in the bulb or the lower part of the tube. Colorless alcohol had apparently separated itself by expansion from a still perfect solution left behind.

This led to making some experiments with solutions, partly aqueous, partly alcoholic, of several colloid substances, such as starch, tannin, caramel, albumen, and gelatin. Each solution was placed in a flask of about half a liter capacity, which was brought to near 0° C. by being surrounded with ice, filled to the mouth with the solution at this temperature, and closed by a cork traversed by a glass tube of small but not capillary bore (about 4 mm. interior diameter), 15 or 20 cm. long, and having a glass stop cock in the middle of its length. The ice having been removed, the temperature of the flask and its contents was allowed to rise gradually in a warm room until the head of the column of liquid in the tube, originally one or two centimeters below the stop cock, had reached to about as far above it. The stop cock was then cautiously closed, and the small portion of liquid above it, removed by means of a capillary pipette, was submitted to appropriate tests for the substance in solution in the contents of the body of the flask. In contrast with a sample of equal volume taken from the flask itself, the portion which had been slowly driven up by expansion was found to contain a diminished amount of material in solution, often a very notably diminished amount, and in two or three instances practically none.

All the solutions tried were filtered beforehand through four thicknesses of fine, close filtering paper, so as to remove suspended particles of solid matter. No film consisting of, or rich in, the material dissolved in the bulk of the liquid could be detected on the inner surface of the tube in its upper part, so that the separation could not well be attributed to surface adhesion.

The extent of exposure to the air on the small cross section of the tube would hardly allow of an explanation being found in chemical change of the dissolved material.

The term apantlesis (*ἀπάντλησις*) might be used to signify a draining away of some of the molecules of the solvent undergoing expansion from among those of the colloid solid in solution. Such draining away would seem to connect itself on to change in the opposite direction, but leading to the same result, when the colloid begins to separate out by gelatinizing on cooling.

The conditions which seemed most to influence the production and the distinctness of the phenomenon were—first, the proportion of the colloid solid in solution; and second, the time occupied in the rise of temperature of the liquid. In regard to each of these conditions, there appeared to be a certain point at which the separation was most notable, above or below which it became gradually less distinct, and sufficiently removed from which it was not observable at all.

* Read before the Chemical Section of the British Association, Manchester meeting.

## SACCHARINE: THE NEW SWEET PRODUCT FROM COAL TAR.*

By Dr. CONSTANTIN FAHLBERG.

THE subject which I am going to bring before you is one which may, perhaps, be known to many of you, at least, by name. In the first place, I think it well to give you a short history of this new and interesting compound, stating how I came to discover it, and what my principal work was during the period of nine years, in developing it for purposes of manufacture on a large scale.

When, in the year 1879, I became connected with the Johns Hopkins University of Baltimore, part of my work was to repeat the older experiments of Latchinow, Anna Wolkow, Remsen, Beckurts, and others, on the toluene sulphamides. I prepared first the toluene sulphamides, in order to study their oxidation products; some of them, the "para" and "meta" compounds, had previously been studied by others, but the "ortho" compound had not been investigated up to that time.

By oxidizing pure orthotoluene sulphamide, I found that it yields a remarkably sweet compound, but the amount obtained by the process employed was so small that it was hopeless to think of making the laboratory experiment fit for a manufacturing process. Not discouraged by this fact, I set to work to study other reactions, in order to get a better yield of the sweet body.

In the first place, the costly anhydrous or fuming sulphuric acid was not fit for yielding sufficient orthotoluene sulphonic acid. It was found that by treating toluene with anhydrous sulphuric acid the parasulphonic acid was the principal product formed. Experimenting with different strengths of acid, it was found that sulphuric acid of 66° Baume answered the purpose best at low temperature, converting almost one-half of the toluene into the orthosulphonic acid.

The next step in the process was the treatment with phosphorus pentachloride—a reaction which cannot be carried out on a large scale. I therefore experimented with phosphorus trichloride, employing a current of chlorine gas, and found by this method of treatment that the action was less violent and more under control, but it gave the same results as when phosphorus pentachloride was employed. In order to manufacture phosphorus trichloride a new apparatus had to be devised, this compound not having been manufactured up to that time in sufficient quantities to warrant the hope of obtaining a continuous supply for my purpose.

The apparatus which I have devised for effecting this object is made of cast iron, and the phosphorus used is the yellow and not the red modification; the apparatus being so constructed as to allow of continuous flow of phosphorus into it through a funnel. With this apparatus an unlimited quantity of the trichloride may be manufactured, the cost of production being comparatively small, while the purity of the article is very high.

In my laboratory work I made use of aqueous ammonia for transforming the orthosulphonic chloride into the amide, but I found that the water was very dangerous, changing the sulphonic chloride frequently back into the sulphonic acid, and not into the amide as desired, and so rendering this step of the process very uncertain. To avoid this inverse reaction, water had to be excluded, and dry ammonia gas had to be used, which again required complicated apparatus and study of the conditions under which the reaction progressed most favorably.

My apparatus as now constructed, and the knowledge which I have gained by patient study of this part of the reaction, have so overcome this inverse reaction as to make the yield almost a theoretical one.

The oxidation of toluene orthosulphamide into saccharine requires great precaution, and it was found necessary to change very materially the work at this stage of the process from the laboratory method to that necessary for a manufacturing operation. In my previous work I had stated that toluene sulphamide yields on oxidation with potassium permanganate two products—namely, saccharine and orthosulphobenzoic acid. At that time I had assumed the reaction to take place with elimination, not of ammonia, as a chemist would be inclined to suppose, but in that of nitrogen. Now I find that this reaction is an entirely different one, that neither ammonia nor nitrogen is formed, but that by oxidation part of the amido group is changed into nitrates in the presence of potassium permanganate.

To check this formation, very dilute solutions have to be employed, and the subsequent evaporation becomes a very expensive operation.

A discovery which took place at this time helped me greatly to utilize the sulphobenzoic acid formed during the process, by transforming it into saccharine. This discovery consisted in the following reaction: If a neutral salt of sulphobenzoic acid be treated with phosphorus pentachloride or with trichloride in a current of chlorine gas, the bichloride formed in this reaction yields, on treatment with ammonia, not, as might be assumed, a diamid, but an ammonium salt of saccharine from which saccharine can be easily separated, like from any other salt of it, by the addition of a mineral acid. The parasulphonic chloride, which forms a bulky mass, in order to carry through the operations to separate the orthosulphonic chloride, is now transformed in autoclaves under pressure, and by superheated steam, into toluene and sulphuric and hydrochloric acids. The toluene is made use of again, and by this reaction almost all the substance started with is transformed finally into saccharine.

Works of such an extensive character as those at Salbke Westerhusen, Germany, erected to supply the whole world with saccharine, require very large quantities of potassium permanganate and phosphorus, and to work economically it is necessary to utilize the manganese hydroxide obtained as a by-product for reconversion into permanganate. It may also be necessary to utilize the phosphate residues for making phosphorus later on, if this material continues to be sold at its present high price, but I hope that the existing phosphorus manufacturers will be able to supply me for some time to come.

From the above statements you can easily conclude that there was much work to be done to put me in the position in which I am at present, to supply the world with a sufficient quantity of saccharine.

My previous publications on saccharine, although of an entirely theoretical value, had not been accurate enough in their statements, so as to leave no doubt about the constitution of saccharine. Remsen, Maumené, and others had speculated on various formulæ for this new body. The former had assumed the formula to be $C_6H_4\begin{cases}COH\\SO_2\end{cases}N$; whereas Maumené had thought to find a similarity between saccharine and taurine, probably through his manipulative errors in the determination of sulphur.

For the formulæ of the salts of saccharine I had assumed the non existence of the orthosulphamine-benzoic acid, and had thought the salts of saccharine corresponded to the formula belonging to sulphamine-benzoic acid. Later on the existence of orthosulphaminebenzoic acid was proved by Noyes, who had oxidized sulphamide with ferricyanide of potassium in an alkaline solution. It now became of the utmost importance to decide between the two formulæ assumed by Remsen and myself; and taking into consideration the work published by Noyes, whether the existence of orthosulphaminebenzoic acid was true or not, and which of the two formulæ really belonged to saccharine—namely, $C_6H_4\begin{cases}COH\\SO_2\end{cases}N$, or the formula suggested by me, $C_6H_4\begin{cases}CO\\SO_2\end{cases}NH$, I repeated the work of Noyes, and found that he was correct in all his statements. At present I have an investigation in progress, which will prove that the above orthosulphaminebenzoic acid of Noyes can also be made in a different way, and with a better yield, which reaction I will make known at a future time. The formulæ for the salts of saccharine, as assumed by me, were accordingly wrong in some respects, as it is impossible for two isomeric orthosulphaminebenzoic acids to exist. On re-examining my salts of saccharine I found them all to correspond to the formula $C_6H_4\begin{cases}CO\\SO_2\end{cases}NM$, in which the hydrogen atom of the imide group is replaced by monad metals, or monad-organic radicals. The ethers, which in my first attempts I found impossible to prepare, I have finally succeeded in forming, and these were greatly instrumental in helping me to prove the constitution of saccharine and its salts, without any doubt whatever. If any of these ethers be inclosed in a sealed tube in the presence of hydrochloric acid, an alkylamine and sulphobenzoic acid are formed. I have proved, in one instance, the existence of ethylamine by the isonitrile reaction of Hofmann and the formation of the double salt of platinum chloride. This transformation proves beyond any doubt the constitution assumed by me, as given above, for saccharine and its salts, as well as for its ethers.

According to the above facts, we must look upon saccharine as an inner-anhydride or benzoylorthosulphonic imide, which yields salts and ethers entirely different from the orthosulphaminebenzoic acid; in fact, I have succeeded in transforming one into the other, and *vice versa*.

If orthosulphaminebenzoic acid be heated, it changes into saccharine (*i. e.*, benzoylorthosulphonic imide) with the elimination of water; if, on the other hand, saccharine be subjected to a current of hydrochloric acid gas in the presence of alcohol, the ether of orthosulphaminebenzoic acid is formed, which also yields, on heating, saccharine, with the exception that in this case not water, but alcohol, is eliminated. A further interesting reaction of the ether of saccharine, and not of orthosulphaminebenzoic acid, is this, that it forms by saponification with an alcoholic solution of potash a double potassium salt of ethylsulphaminebenzoic acid having the formula $COOK-C_6H_4-SO_2N.KC_2H_5$. If this compound be treated with hydrochloric acid, or any mineral acid, the potassium is eliminated, and an

* Read before the British Association, at Manchester, September 5, 1887.

isomeric compound of the ether of orthosulphaminebenzoic acid is formed, which I have designated as ethylsulphaminebenzoic acid, and which is isomeric with the above stated ether of orthosulphaminebenzoic acid. I have an investigation in progress which will prove that these reactions hold good for all sulphimides; as, for instance, terephthalic and mesitylenic sulphimides, and other bodies of the same constitution.

Having mentioned the first difficulties which I met with, and having given you a short outline of the chemical side of the saccharine question (the material which has been of late so prominently before the public notice), I wish, at this stage of my paper, to call your attention to the uses of saccharine in the arts, in the household, and in medicine. I may say that there are at the present moment a number of manufacturers using saccharine already for the purposes of sweetening bread, cakes, champagne, lemonade, oils, essences, and medicines of all kinds. Its sweetening power being three hundred times greater than that of sugar, you can imagine that it will serve for many purposes to which sugar cannot be applied, such as disguising the unpleasant taste of medicines, and be used in flavoring the food of patients to whom the use of sugar would be injurious.

One very important fact must be here pointed out with respect to saccharine, and that is its non-fermentable character, distinguishing it from the sweetening materials belonging to the carbohydrate class or sugar family proper. It is in no way altered by the action of yeast or other ferments, in the way that the carbohydrates are degraded; in fact, it rather acts in such a way as to prevent fermentation, so that saccharine retains its sweetening property under all conditions for an indefinite time.

In addition to the high sweetening power of saccharine, it has also antiseptic properties, which will make it useful in preserving articles of food, as I have frequently seen suggested in the newspapers. It is nothing more than a condiment or spice, and should never be tasted in the pure state, because taken in too large a quantity it will act upon the nerves in such a way as to paralyze the sense of taste, just as powerful music stuns or deadens the auditory nerves, or a very bright light acts upon the optic nerves.

I may inform you that almond and other breads are now to be had sweetened with saccharine, as well as champagne similarly sweetened, for diabetic patients and those suffering from fatty degeneration.

[Continued from SUPPLEMENT, No. 618, page 9873.]

## PLANT ANALYSIS AS AN APPLIED SCIENCE.[1]

By HELEN C. DE S. ABBOTT.

VERY many dye substances of vegetable origin are used industrially. It would detain us too long to enumerate the list, and I shall select a few of the well-known ones for illustration:

The dyewoods imported in a crude state are as follows:[2]

*Camwood:*

| | Tons. | Value. |
|---|---|---|
| 1884 | 659·82 | $65,461.00 |
| 1885 | 730 | 68,721.00 |

*Fustic:*

| | Tons. | Value. |
|---|---|---|
| 1884 | 11,811 | $177,830.00 |
| 1885 | 8,090 | 119,689.00 |

*Logwood:*

| | Tons. | Value. |
|---|---|---|
| 1884 | 55,921·59 | $875,291.00 |
| 1885 | 56,507·80 | 904,205.25 |

The madder plant was formerly grown to a large extent in many countries, and in France[3] large tracts of land were given up to its cultivation. "Madder[4] owes its importance to the beauty and fastness of the tints it yields, and to the fact that by a variation of the mordants used, it produces rose pink, black, violet, lilac, and puce colors." The character of the soil where the madder grows affects the color of the dye. The roots grown in a rich clay soil exhibit a rose pink color; under other conditions, a deep red coloration.

Alizarin, the chief coloring matter of madder, is now produced artificially from coal tar in large quantities, though the madder is especially in request for woolen dyeing. This plant, which yielded such large revenues to the growers, is replaced by a cheaper manufactured product. Very likely we should not have discovered the synthesis of its valuable dye if our attention had not first been directed to it in the plant.

When it is remembered that coal tar is undoubtedly of vegetable origin, the many brilliant dyes derived from this source are only evidences of what plant chemistry could have found in the carboniferous ages.

The following statistics show:

*The amount[5] of imported madder:*

| | Pounds. | Value. |
|---|---|---|
| 1884 | 253,385 | $13,521.00 |

*Ground or prepared madder:*

| | Pounds. | Value. |
|---|---|---|
| 1884 | 1,458,313 | $111,456.00 |
| 1885 | 1,211,370 | 80,628.00 |

*The natural or artificial alizarin:*

| | Pounds. | Value. |
|---|---|---|
| 1884 | 778,660 | $296,123.00 |
| 1885 | 1,470,864 | 404,002.00 |

*Total value madder and alizarin:*

| | |
|---|---|
| 1884 | $421,100.00 |
| 1885 | 484,630.00 |

Many species of plants grown in different parts of the world, but especially the *Indigofera*, yield a glucoside called indican, which under the influence of dilute mineral acids and certain ferments breaks up, yielding indigo blue and a substance resembling glucose.

"Indigo[1] has undoubtedly been known in Asia from a very remote period of antiquity, since there exists in very ancient records, written in the Sanskrit language, descriptions of its mode of preparation mainly not different from the methods yet in use." The manner of cutting the plant and extracting the indigo is not the same in all countries. In India, the plants are grown from seed which are sown in the fall and spring, according to the kind of plant. As soon as the young plants are sufficiently forward, they are replanted in regular rows. The flower buds are pulled off before they are fully developed, experience having taught that by so doing the leaves of the shrub become larger and yield more indigo, the coloring matter being chiefly present in the leaves.

The indigo of commerce is a blue dyestuff extracted by fermentation. Other plants[2] used occasionally for the extraction of indigo are more frequently employed directly in dyeing; they belong to the *Polygonaceæ* family. These plants are from India, China, Central Africa, and South America, and they can be acclimated in all warm countries. In the mode of indigo manufacture[3] two processes are employed. In the one the dry leaves are used, in the other the green leaves. This is the one in most common use. When the plant begins to flower, it is cut down at about six inches from the ground and carried to the steeping vats with as little delay as possible, strewn horizontally into the vats, and pressed down by means of beams fixed into side posts, bamboo being placed under the beams. Water is immediately run in just sufficient to cover the plant. The pure water from the Ganges is especially sought for in these manufactories, and many indigo factories line the river banks. The time for steeping depends much on the temperature of the atmosphere, and can only be learned by experience and careful watching of the vats; but in close, sultry weather, with the thermometer at 96° in the shade, eleven or twelve hours is sufficient. In cooler weather more time is requisite.

When fermentation is established, the surface of the vat is covered with a violet scum. The liquid is drawn off through plug holes, in the wall of the vat. The fecula at the bottom is then removed to the boiler. It is brought to the boiling point as quickly as possible, and kept there for five or six hours. While boiling it is stirred to keep the indigo from burning and skimmed with a perforated ladle. When sufficiently boiled it is run off to the straining table, where it remains twelve or fifteen hours draining. It is then taken to the presses and gradually pressed. This process takes twelve hours. It is then ready to be taken out, cut, stamped, and laid in the drying house to dry.

In the manufacture of indigo the ordinary processes of fermentation, drawing off the liquor, beating, and collecting the fecula are generally well known, and are followed with but trifling variation in different provinces and manufactories in India. The main points appear to be the watching and the soaking of the plant so as to be able to tap off the infused liquid exactly at the right point of fermentation, and next to beat the liquid in the second vat long enough.

Indigotin as it is contained in the vegetable tissues is colorless, but it becomes blue on contact with air. If it is desired to change indigo blue to indigo white, it is only necessary to place it in the presence of a deoxidizing and alkaline liquid, but as soon as air is admitted its blue color is resumed.

The dyeing of fabrics is based upon the transformation of indigo blue into soluble indigo white. The colorless matter is placed on the stuff, which becomes blue by exposure. The solubility of indigo in sulphuric acid is utilized for blue dyeing of wools.

Indigo has been made artificially by several methods, though the process so far is too expensive to manufacture the compound to replace the commercial supply from plants.

The table of statistics is as follows:

*Amount of indigo[4] imported:*

| | Pounds. | Value. |
|---|---|---|
| 1884 | 3,074·48 | $2,267,048.00 |
| 1885 | 3,035,934 | 2,007,066.00 |

*Artificial indigo:*

| | Pounds. | Value. |
|---|---|---|
| 1884 | None. | .... |
| 1885 | 3,300 | $3,600.00 |

The dye commonly known as logwood has been cultivated in Jamaica[5] since 1715, and has been known and used in Europe from a short period after the discovery of America. The commercial supply of the dye is from *Hæmatoxylin campechianum*, a tree belonging to the natural order *Leguminosæ*. It is the wood of the tree which is used, and is met in commerce in the shape of large irregular blocks.

The only other tree besides logwood in which hæmatoxylin so far has been discovered is the *Saraca indica* of the same natural order.

I stated[6] before the Academy of Natural Sciences, in November, the discovery of this principle in my analysis of the bark of the *Saraca indica*.

The *Saraca indica*[7] is called in India the asok or asoka tree, and it is said when this tree is in full blossom there is nothing in the vegetable kingdom which affords a more beautiful object. Frequent mention is made of the plant in Hindoo mythology, and the bark is much used by native physicians in some diseases.

I undertook the analysis of this bark at the request of Messrs. Parke, Davis & Co., of Detroit, Mich., who liberally furnished me with a supply of the drug. The coloring principle exists in the bark in two or more conditions—as hæmatoxylin and as oxidized products. The former was separated as yellow crystals, analogous in form to hæmatoxylin crystals from the true logwood. The alcoholic extract of the bark contained about 18 per cent. of a red colored substance, which agreed in color and dye tests with like constituents found in logwood. Mordanted cotton fabric was dyed with hæmatoxylin from Saraca bark, and presented the characteristic logwood dye colors.

The extracts of *Saraca indica* bark containing its coloring principle were tested with various reagents,[1] and it was observed that the reactions agreed with hæmatoxylin colors, and in no case with those of brazillin.

The bark of the commercial logwood tree is not used for extracting the dye, the wood of the tree being employed for this purpose. I determined the presence of a small quantity of hæmatoxylin in the logwood bark, and obtained with its extracts the same reaction without alkalies and other reagents as with the other wood extracts. But owing to the smaller percentage of dye in the bark of the specimens examined, the colors were less intense. In the case of the *Saraca indica* bark, the colors were very brilliant, and certainly indicated the presence of a large proportion of coloring matter in it. It would be of interest to secure specimens of the wood of *Saraca*, in order to determine if it contains the coloring principle, and should this be so, if it exists in sufficiently large quantities to warrant its introduction as a new source of this commercial product.

Last summer[2] I extracted from a Honduras plant, called "chichipate," a yellow dye. It yielded with mordanted wool fabrics colors resembling somewhat those yielded by fustic wood. A plant[3] was analyzed in the laboratory of Parke, Davis & Co., named *Cascara amargo*, from which a new alkaloid, pacrammine, was separated. This alkaloid is like berberine in its properties. Specimens of this plant were lately forwarded to me, and there is every indication of the relationship of identity of "chichipate" and *Cascara amargo*. This incident is significant as deciding by means of chemical analysis the identity of plants under distinct names from different regions. No analysis under the name of "chichipate" had ever been published until my own report. The dyeing property of the substance, chichipatin, separated from "chichipate," I think is quite independent of the alkaloid, though berberine, it is well known, yields yellow colors with wool. I also separated a new camphor from this plant. It is crystalline, and under polarized light gives a beautiful play of colors.

During the year 1886, Prof. Trimble[4] separated a new crystalline camphor, phloxol, from the underground portion of *Phlox carolina*. This substance resembles the camphor found in chichipate. It is soluble in petroleum ether, and this solvent is suggested as a means of distinguishing powdered *Phlox carolina* from *Spigelia*. The latter contains no camphor. *Phlox* is frequently put on the market for *Spigelia*. The two drugs in the normal condition can be readily identified.

An estimate of the profitable ends of the chemical analysis of plants may be gathered from the above statements.

Plant analysis covers a wide field, for it includes the chemistry of the living and the dead plant. Its application to various industries is far reaching.

Plant analysis in this conntry has been called an "infant industry." There are probably differences of opinion about the infant needing protection. It certainly needs encouragement and support, when its importance as a citizen is recognized.

Plant chemistry should not only be directed toward the study of new plants, but in the study of old plants it is to be encouraged, for each new investigation of many well known plants has revealed new chemical principles, and given additional knowledge of the old ones. We can never know to what practical uses the constituents of any plants may be brought, and the money value of this information should be considered.

Many chemical compounds which are of the most practical use, now made by synthesis, were first discovered in plants, products of living matter.

Synthetical chemistry has derived its knowledge from the results of analytical study. Researches in plant analysis have revealed many facts, though the exploration field is still wide.

In our present state of knowledge, plant chemistry is a safe political ground for either the protectionist or free trader. The vegetable cell has placed the tariff of human penetration so high, and protected so well its industry, that the plant enjoys the monopoly of proteids and a magazine of other substances. The free trader may console himself, for if he is intelligent enough he can find out the processes, and start his own factory, duty free.

Prof. Cohn, of Breslau, tells us that it is only a question of time when we may hope for the chemist to succeed in doing what the simplest *Alga* and mosses are able to do, namely, to produce starch from carbonic acid and water. On that day the bread problem, which is in fact the greatest of all social problems, will be solved.

It is indeed true that those organic compounds which are of the most importance in the life of the plant, the hydrocarbons and the albuminoids, are those which as yet have not permitted the secrets of their production to be discovered.

In the future, when synthesis has accomplished this prophecy and the synthetical chemist reigns supreme, our coming race to my imagination will be chemists, and our farmers will manufacture our food supply of proteids, sugars, and starch. The surface of the land will be one huge teeming laboratory. The plants, the analytical chemist and others of his race, asphyxiated by their environment, will have long ago passed away into a suffocating forgetfulness.

But, for the present, we must be satisfied to depend upon our humble colleagues, the plants, for our food and beverages, our fabrics, perfumes, and dyestuffs, our medicines, and other things too numerous to mention.

---

[1] A lecture delivered before the Franklin Institute, January 17, 1887. From the *Journal of the Franklin Institute*.

[2] Bureau of Statistics, Treas. Dept., 1885.

[3] Tropical Agriculture. By P. L. Simmonds. London, 1877. P. 309.

[4] Hand Book of Dyeing and Calico Printing. By W. Crookes. London, 1874. P. 228.

[5] Bureau of Statistics, 1885.

[1] Hand Book of Dyeing and Calico Printing. W. Crookes. P. 447.

[2] Matieres Premieres Organiques. Par Pennetier. P. 513.

[3] Matieres Premieres Organiques, p. 516. Bul. de la Societe Industrielle de Mulhouse, vol. xxviii, p. 307.

[4] Bureau of Statistics. 1885.

[5] Crookes, p. 342.

[6] "On Hæmatoxylin in the Bark of Saraca Indica." By Helen C. De S. Abbott. Proc. Acad. Nat. Sciences. Phila., Nov. 30, 1886.

[7] The Materia Medica of the Hindus. By Udoy Chaud Dutt. Calcutta, 1877.

[1] S. P Sadtler and W. L. Rowland. *Amer. Jour. Pharm.* Feb., 1881.

[2] "Preliminary Analysis of a Honduras Plant, named 'Chichipate.'" Paper read before the A. A. A. S., at Buffalo, August, 1886.

[3] "Cascara Amargo." By F. A. Thompson. *The Ther. Gazette*, Jan. 15, 1884, p. 8.

[4] "An Analysis of the Underground Portion of Phlox Carolina." By Henry Trimble. *Amer. Jour. Pharm.*, October, 1886, p. 479.

## MANIA AND INEBRIETY.

By T. D. CROTHERS, M.D., Hartford, Conn.

THE following cases bring out the facts I wish to present:

A—— had two attacks of acute mania in five years

and recovered. He was able to go on with his business (that of a builder) with no apparent evidence of incapacity. He was a temperate, hard-working man, but had a neurotic heredity. Premonitions of another attack of mania appeared, and arrangements were made for his removal to an asylum, when he suddenly disappeared.

Two weeks later he was found in a hotel, where he had been intoxicated every day, but attracted no attention in act or thought. His removal home was followed by a rapid recovery, and soon he went about his business as usual. Ten months later, after a period of excitement, he rushed to a saloon and drank to stupor. He was taken home, was delirious for a week, and then recovered. Two months after, he secreted himself in a saloon and drank for a week to stupor, then went home fully conscious and recovered. Since that time he has had three attacks in which the impulse to procure spirits was uncontrollable. On two of these occasions he was restrained, developing a confused mania of two weeks' duration and a long period of convalescence. On the third attack he ran away, and after four or five days' drinking to stupor returned, and recovered rapidly.

This question came up: Should he be allowed to go away and drink to great excess when the drink impulse came on? or, Should he be restrained at home or in some asylum, where he would probably have mania?

The increasing frequency of these paroxysms, and the large business interests under his control, started inquiry as to his mental responsibility. Two medical experts found no indications of insanity or mental incapacity, based on an examination in the free intervals of his paroxysms. The drink impulse was regarded as a moral lapse, and the mania appearing when he could not procure spirits as simulation.

In my opinion this man was insane, and the paroxysmal inebriety was only a symptom. His real mental condition was concealed, because he lived along accustomed lines of thought and act, and hence acted automatically, and could keep up a semblance of sanity without effort.

B—— came under my care, a neurotic by inheritance and a periodic inebriate. Nothing unusual was noted until the return of the paroxysm, when he ran away, and was found a short time after, having drunk two or three glasses of spirits. He was placed under restraint, and very soon after had an attack of acute mania. This lasted twenty-four hours.

After a week's convalescence he was about again as usual. The return of the next paroxysm was marked by the same mania, when restrained, of nearly the same intensity and duration.

He escaped on the return of the third paroxysm, and drank to stupor for two days, then was found and returned. The recovery was rapid, and later he was placed in the care of another physician. Here the same experience was repeated. The drink paroxysm became a confused, trembling mania when restrained from procuring spirits; but if he could be intoxicated for a day or more, he would recover rapidly. Nothing less than profound stupor seemed to break up the mania.

This man possessed property, and the same question of responsibility came up. Like all others of this class, he had delusions of power to stop at will, and regarded his drinking as moral weakness and of little moment.

The following case came to me for consultation: A man in active business suffered from a heat stroke, and soon after became a periodic inebriate. These drink periods were always preceded by states of unusual exhilaration, great buoyancy of spirits, self-confidence, and muscular activity. His wit and humor were overflowing and boisterous, then suddenly he would disappear and be found later stupidly intoxicated.

If any obstacles intervened, he would spend large sums of money to procure spirits, seeking retirement where he could indulge unmolested. In a few days he would recover and go home, and after a short period of rest go out again as before.

These periods increased in frequency and duration, and the question of placing him under restraint when the premonitory mental exhilaration came on was proposed. He consented, and was placed in a private insane asylum. Two days after, he had an attack of acute mania, and did not recover so as to go out for two months.

On the return of the next attack he went to a physician's house, where the mania reappeared with great severity.

At the next attack he ran away, and was stupidly intoxicated for four days, and then quickly recovered.

On the next occasion he was restrained in a hospital, had mania, ran away, became intoxicated, and while in this state lost large sums of money. The same question of responsibility, and what should be done, came up. To the advice to give up business and go under medical care, the objections were his apparent good health and large business interests, which he conducted with pleasure and skill, and temperate life in every respect except at these periods. Occupation of both mind and body seemed essential to his health. To give up business and travel was especially dangerous, and to restrain him when these periods came on always developed mania. If allowed to drink to stupor for a time, other dangers appeared. In these drunken states he gave away large sums of money and signed notes.

The counsel of many eminent men has been sought, and still no solution has been reached.

In the future the narcotic action of alcohol will fail, then permanent mania will appear. When alcohol is withheld, mania comes on; when it is given, the mania is prevented.

These cases are unusual, but they outline many symptoms and conditions that are more or less common in all periodical cases of inebriety and dipsomania.

The drink impulses in these periodical cases are states of mania seeking relief from some psychical pain or agony. This may be found in drugs as well as alcohol, and when ungratified manifests itself in complex mental symptoms of disorder and disease.

A clergyman who was a periodical inebriate, and was cured, has regularly every three months short periods of intense mental irritation. At these times he is angry at everything, is suspicious, and abuses his best friends. When this passes away he apologizes, and regrets his conduct keenly. He has not drunk any for four years. These periods last for three days or more, and are literally manias.

A professor in a medical college, who used alcohol to excess for years, and then abstained, has periods of two or three days' duration during which he is plunged into the deepest melancholy, with the belief that he is going to die; hence gives up business for a time. Then suddenly the melancholy will pass away like a cloud, and he will laugh at his past fears and conduct.

These cases, which exhibit many phases of mental degeneration in distinct paroxysms, are common in persons who have drunk to excess and become abstainers. Are they caused by the drink paroxysms of long ago? or are they symptoms of other mental disease which have been aborted by the drink impulse and exist as traces of other brain disorder?

In some cases it is clear that the drink impulse is another form of insanity, which from unknown causes develops in this way.

The very close relation which exists between these periodical drink impulses and complex manias, and the alternation of one with the other, open new fields of research, which often have great practical interest. Thus in one case where the drink impulse was preceded by melancholy, an important will was written that indicated incompetency, and was in the courts for years. This depended on the failure of the physicians to understand the mental condition of the victim.

Another case comes into court where a merchant kills a clerk for his efforts to prevent him from drinking. He was suffering from mania, which preceded or followed restraint from drink. A periodical inebriate made some business transaction which wrecked a large firm, and then developed the drink impulse. The unusual character of this act, just before the drinking period, indicated mania and incompetency, but the court failed to recognize this. The family physician often recognizes states and conditions that are manias, pointing clearly to the irresponsibility of the person. When called to give testimony in court, he finds himself unsupported by any teachings of authority, and hence fails to make his views clear.

The following conclusions may be stated as authoritative, and fully sustained by all clinical study so far: The inebriate is in all cases, as a rule, insane, and of lessened capacity to reason and act normally. The periodic inebriate suffers from a marked mania, which may turn in any direction, taking on almost any form.

Careful study of the symptoms of these cases indicates the gravity of the brain degeneration and the incapacity of the victim. It also points out the intimate association of periodical inebriety with insanity. The drink impulse when gratified may prevent a more serious outbreak of insanity and permanent brain lesion. The inebriety is often a symptom of brain disease.

The responsibility and mental integrity of periodical inebriates should always be the subject of investigation, under all circumstances and conditions.—*Med. Record.*


# THE SCIENTIFIC AMERICAN Architects and Builders Edition.

## $2.50 a Year. Single Copies, 25 cts.

This is a Special Edition of the SCIENTIFIC AMERICAN, issued monthly—on the first day of the month. Each number contains about forty large quarto pages, equal to about two hundred ordinary book pages, forming, practically, a large and splendid **Magazine of Architecture,** richly adorned with *elegant plates in colors* and with fine engravings, illustrating the most interesting examples of modern Architectural Construction and allied subjects.

A special feature is the presentation in each number of a variety of the latest and best plans for private residences, city and country, including those of very moderate cost as well as the more expensive. Drawings in perspective and in color are given, together with full Plans, Specifications, Costs, Bills of Estimate, and Sheets of Details.

No other building paper contains so many plans, details, and specifications regularly presented as the SCIENTIFIC AMERICAN. Hundreds of dwellings have already been erected on the various plans we have issued during the past year, and many others are in process of construction.

Architects, Builders, and Owners will find this work valuable in furnishing fresh and useful suggestions. All who contemplate building or improving homes, or erecting structures of any kind, have before them in this work an almost *endless series of the latest and best examples* from which to make selections, thus saving time and money.

Many other subjects, including Sewerage, Piping, Lighting, Warming, Ventilating, Decorating, Laying out of Grounds, etc., are illustrated. An extensive Compendium of Manufacturers' Announcements is also given, in which the most reliable and approved Building Materials, Goods, Machines, Tools, and Appliances are described and illustrated, with addresses of the makers, etc.

The fullness, richness, cheapness, and convenience of this work have won for it the **Largest Circulation** of any Architectural publication in the world.

**MUNN & CO., Publishers,**
**361 Broadway, New York.**

A Catalogue of valuable books on Architecture, Building, Carpentry, Masonry, Heating, Warming, Lighting, Ventilation, and all branches of industry pertaining to the art of Building, is supplied free of charge, sent to any address.

## Building Plans and Specifications.

In connection with the publication of the BUILDING EDITION of the SCIENTIFIC AMERICAN, Messrs. Munn & Co. furnish plans and specifications for buildings of every kind, including Churches, Schools, Stores, Dwellings, Carriage Houses, Barns, etc.

In this work they are assisted by able and experienced architects. Full plans, details, and specifications for the various buildings illustrated in this paper can be supplied.

Those who contemplate building, or who wish to alter, improve, extend, or add to existing buildings, whether wings, porches, bay windows, or attic rooms, are invited to communicate with the undersigned. Our work extends to all parts of the country. Estimates, plans, and drawings promptly prepared. Terms moderate. Address

MUNN & CO., 361 BROADWAY, NEW YORK.



THE

# Scientific American Supplement.

**PUBLISHED WEEKLY.**

**Terms of Subscription, $5 a year.**

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

**MUNN & CO., Publishers,**
**361 Broadway, New York, N. Y.**


## TABLE OF CONTENTS.


PAGE

I. ASTRONOMY.—The Applications of Photography in Astronomy.—By DAVID GILL, LL.D., F.R.S.—An interesting review of the titular subject.—The work on the international star charts.—A tribute to Henry Draper memorial ... 9874

II. BIOGRAPHY.—Prince Ch'un.—Note, with portrait, of the character and dispositions of the father of the present emperor of China.—1 illustration ... 9875

III. BOTANY.—The Clove Tree.—The cultivation of this important tree.—The methods of gathering the crop.—Its life and fecundity.—The Cultivation of the Castor Oil Plant.—The requirements for successful cultivation of this crop.—Analyses showing soil requirements.—Gathering of the beans ... 9864

IV. CHEMISTRY.—On a Partial Separation of the Constituents of a Solution during Expansion by Rise of Temperature.—By Prof. J. W. MALLET, F.R.S.—A valuable and original contribution to the chemistry of solution ... 9866
Plant Analysis as an Applied Science.—By HELEN C. DE S. ABBOTT.—Continuation of this remarkable paper, with remarks on the value of this line of investigation ... 9866
Saccharine: The New Sweet Product from Coal Tar.—By Dr. CONSTANTIN FAHLBERG.—The discoverer's own account of this remarkable substance and sugar substitute ... 9866

V. ELECTRICITY.—Danger from Lightning.—By Prof. A. E. DOLBEAR.—Practical notes on this important subject ... 9867
The Part Played by Electricity in Crystallization.—Continuation of this important paper, giving further results of Prof. Decharme's work.—12 illustrations ... 9868

VI. ENGINEERING.—Castings in Metal from Carbonized Fabrics.—The Franklin Institute report on the Outerbridge process, recently described in this paper ... 9870
Improved Duplex Gas Generator.—The Thwaite process for making water gas.—Its reactions and results.—4 illustrations ... 9870
The Blair Crossing Bridge.—Elaborate description of this bridge over the Missouri River, with cost of erection.—17 illustrations ... 9870
Sub-surface Water Supplies.—By Prof. W. P. TROWBRIDGE.—The question of driven, artesian, and excavated wells examined.—Strata of water supply and practical results in utilizing the same ... 9862

VII. GEOGRAPHY AND TRAVEL.—A Sailing Boat of New Guinea.—Description of a New Guinea "lakatoi" or trading vessel employed in coast traffic.—1 illustration ... 9871
British North Borneo.—The land of the orang-outang; the edible birds' nests; taking a photograph of a dead orang-outang.—2 illustrations ... 9869
New Guinea Exploration.—Results of a recent private exploring party; the climate, products, and anthropology of the interior ... 9869
The Republic of Counani.—A republic near French Guiana, now extinct: the story of its brief life and early ending.—4 illustrations ... 9861

VIII. GEOLOGY.—The Landslip at Zug.—An accurate account of the catastrophe by which a portion of the town of Zug was ingulfed.—Cause and extent of the disaster.—1 illustration ... 9867

IX. MISCELLANEOUS.—The Herkomer School.—The recent meeting of the Herkomer school, the first one under the new constitution, with extracts from Prof. HERKOMER'S address ... 9865

X. NAVAL ENGINEERING.—Stern Wheel Steamer for the River Magdalena.—A new light draught steel steamer built by Yarrow & Co., for South American waters; with dimensions.—1 illustration ... 9869
The Austro-Hungarian Torpedo Catcher Meteor.—A fast vessel recently built at Elbing, by Herr F. SCHICHAU.—1 illustration ... 9869

XI. TECHNOLOGY.—Improved Steam Oven.—The Wieghorst oven described and illustrated, and its results in bread making.—1 illustration ... 9869

XII. VITAL SCIENCE.—Human Life.—The rapid increase of population; application of calculation to England's future inhabitants.—The pessimistic view of the future of the world ... 9873
Mania and Inebriety.—By T. D. CROTHERS, M.D.—The Correlation of the two failings deduced from instances actually cited ... 9866



# PATENTS.

In connection with the **Scientific American,** Messrs. MUNN & Co. are solicitors of American and Foreign Patents, have had 42 years' experience, and now have the largest establishment in the world. Patents are obtained on the best terms.

A special notice is made in the **Scientific American** of all inventions patented through this Agency, with the name and residence of the Patentee. By the immense circulation thus given, public attention is directed to the merits of the new patent, and sales or introduction often easily effected.

Any person who has made a new discovery or invention can ascertain, free of charge, whether a patent can probably be obtained, by writing to MUNN & Co.

We also send free our Hand Book about the Patent Laws, Patents, Caveats, Trade Marks, their costs, and how procured. Address

**MUNN & CO.,**
**361 Broadway, New York.**

**Branch Office, 622 and 624 F St., Washington, D. C.**